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IT PAYS TO ASK THE MEN WHO KNOW

The manufacture of a spring form does not always run as smoothly as planned.

The spring shown above is a typical example. The designer specified annealed wire to withstand the sharp bends, relying on subsequent heat treatment to impart spring temper. Brittleness was encountered in the finished piece. Then a sample was sent us. Wickwire Spencer experts immediately recognized a known difficulty and recommended a wire slightly cold worked after annealing that would form successfully and possess excellent spring quality after final heat treatment.

Manufacturers are urged when planning production to send in a wire form or spring and description of its use for our recommendation as to the correct wire to be used. This service costs you nothing yet may save you endless trouble, delay and expense in struggling with a problem that our engineers have successfully met again and again.

Wickwire Spencer manufactures High and Low Carbon Wires—in various tempers, grades and finishes—for your specific purpose. Hard-Drawn, soft or annealed Basic or Bessemer Wires—Hard-Drawn annealed, or oil-tempered Spring Wire, Chrome Vanadium Spring Wire—Valve Spring—Music—Clip—Pin—Hairpin—Hook and Eye—Broom—Stapling—Bookbinding—Dent Spacer Wire—Reed Wire—Clock—Pinion—Needle-Bar—Screw Stock—Armature Binding—Brush—Card—Florist—Mattress—Shaped—Rope—Welding. Flat Wire and Strip Steel, High or Low Carbon—Hard, annealed or tempered—Clock Spring Steel—Corrosion and Heat Resisting Wires.

WICKWIRE SPENCER STEEL COMPANY
New York Worcester Buffalo Chicago San Francisco

DETROIT REPRESENTATIVE:
CRAINE-SCHRAGE STEEL CO.
8701 Epworth Boulevard

WISSCO WIRE
by Wickwire Spencer

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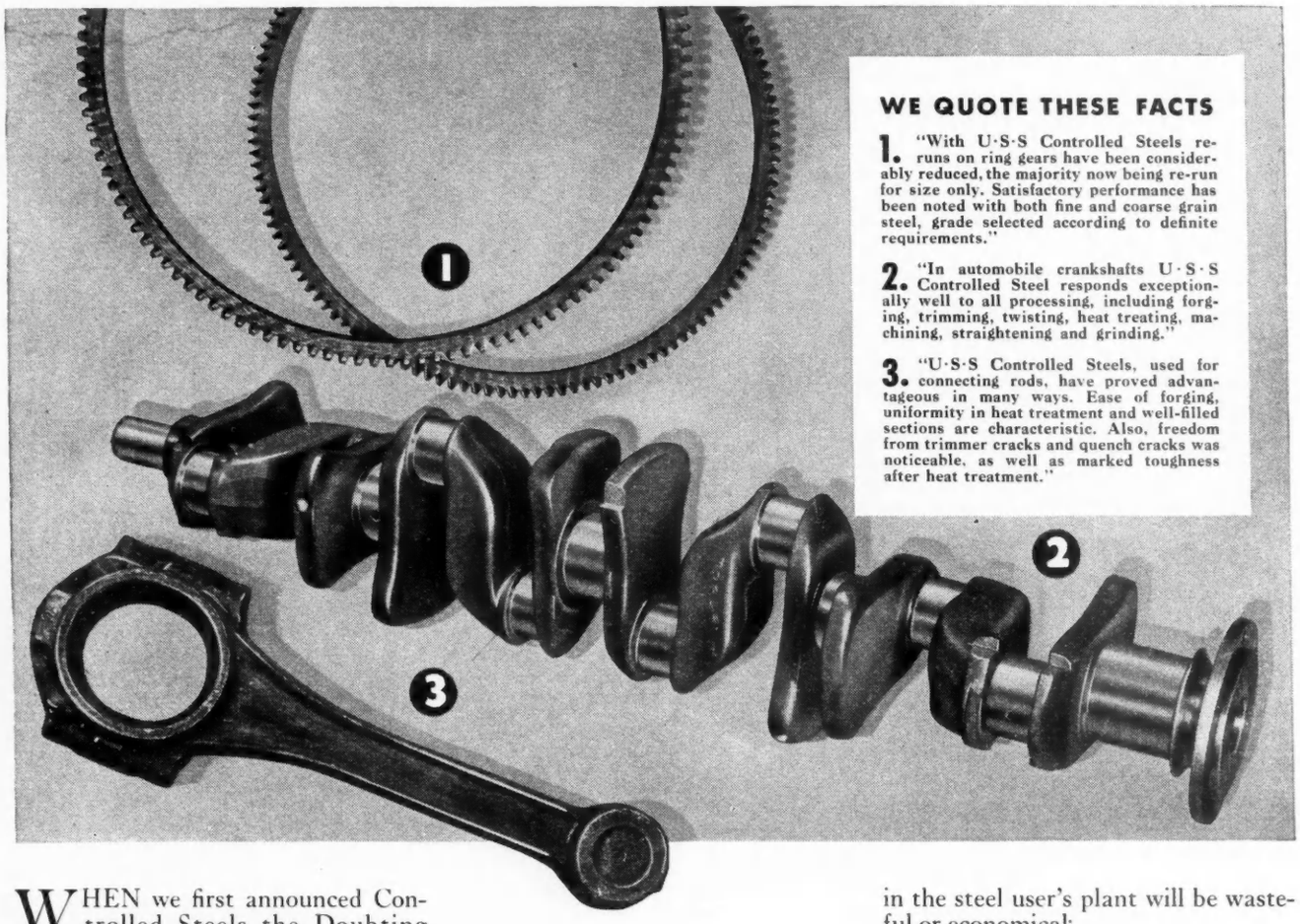
Is there a Skeptic in the House?


WE QUOTE THESE FACTS
1. "With U·S·S Controlled Steels reruns on ring gears have been considerably reduced, the majority now being re-run for size only. Satisfactory performance has been noted with both fine and coarse grain steel, grade selected according to definite requirements."
2. "In automobile crankshafts U·S·S Controlled Steel responds exceptionally well to all processing, including forging, trimming, twisting, heat treating, machining, straightening and grinding."
3. "U·S·S Controlled Steels, used for connecting rods, have proved advantageous in many ways. Ease of forging, uniformity in heat treatment and well-filled sections are characteristic. Also, freedom from trimmer cracks and quench cracks was noticeable, as well as marked toughness after heat treatment."
1
2
3

WHEN we first announced Controlled Steels the Doubting Thomases had a field day. When we said that we could produce carbon steels in which *all* quality factors could be predetermined, in which variables could be scientifically eliminated, they were definitely from Missouri.

Now, only a few years later, many of them are among the largest users of U·S·S Controlled Steels. The drastic savings made in plants all over the country, due to better machining—reduced heat-treatment costs—easier forging and forming—and more consistent and uniform production generally have conclusively proved the case for U·S·S Controlled Steels.

Today in shops whose combined cost reductions run into hundreds of thousands of dollars yearly, they swear by these superior carbon steels.

In U·S·S Controlled Steels, control goes further than the mere close adherence to chemical specifications. It has to do with control of other vitally important properties — forging and machining qualities, response to heat-treatment, ductility, etc. — which so largely determine whether production in the steel user's plant will be wasteful or economical.

In U·S·S Controlled Steel we have proved it quite possible to furnish not only fine grain or coarse grain steel as required, but to maintain uniformity in shipment after shipment. Thus tool set-ups, heat-treating and forging procedures, once established for the steel, require minimum change. Reduced costs and better results follow as a matter of course.

Why not invite one of our metallurgists to look over your production line? If U·S·S Controlled Steels will save you money he will show you how to use them to best advantage.

USS *Controlled* STEELS

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

Published Weekly
Founded 1895

AUTOMOTIVE INDUSTRIES

Vol. 80, No. 11
March 18, 1939

Week's Production Estimated at 82,000

Present Rate Points to March Total of 365,000

In spite of unfavorable weather conditions in many parts of the country which have retarded the opening of the spring selling season to some extent, car and truck manufacturers during the current week consolidated the production gains established a week ago

A mid-week check of factory schedules indicated that the industry would even show a gain of approximately 1000 cars and trucks in the week ending March 18 over the previous week to bring output slightly over the 82,000 mark. This brings the March total to date to approximately 200,000 cars and trucks and with two full weeks to go the monthly total should be in the neighborhood of 365,000 without any appreciable change in present schedules. The industry turned out 238,597 cars and trucks in March, 1938, so present output is running at least 53 per cent ahead of last year.

Hudson and Nash in the independent field expected to register slight gains over their improved standings of last week while Studebaker, Chevrolet and Buick maintained the increased pace previously established. Pontiac also was expected to turn out several hundred units over its previous schedules. Further conservative increases are anticipated in coming weeks, although as previously pointed out, the week-to-week change is not expected to be great because of the relatively high rate

(*Turn to page* 359, *please*)

United Aircraft Realized Profit of $5,426,275 in '38

In 1938 the United Aircraft Corp. and its subsidiaries realized a consolidated net profit of $5,426,275, or at the rate of approximately $2.12 a share on the average number of shares outstanding during the year. A dividend of 50 cents a share was paid on June 15, 1938, and another of 75 cents a share on Dec. 15, 1938, involving a total dividend disbursement of $3,245,841.

AUTOMOTIVE INDUSTRIES

Summary of Automotive Production Activity
(Week Ending March 18)

BUSES Renewed interest in advanced models has been expressed by several large transportation operators in recent weeks. Inquiries in respect to riding comfort and air-conditioning have been reported. Little change in manufacturing operations.

TRUCKS Two prominent producers voice opinion that "barring unforeseen events, 1939 will be extremely satisfactory." Factory representatives who have been contacting dealers in recent weeks report stocks generally low with substantial amounts of unfilled orders. This is accounted for in part by the fact that many vehicles which ordinarily would have been turned in during 1938 were made to do duty until this spring.

TRACTORS Production remains at fairly constant pace. No serious inroads made as yet on dealer stocks, but a few weeks of favorable weather would materially change the picture. A number of concerns are concentrating on production of the small all-purpose type. Opinion now seems to be that 1939 will be a below-normal "tractor year" with commodity prices still uncertain.

AUTOMOBILES Output for the week ended March 18 is estimated at slightly more than 82,000, an advance of 1000 cars and trucks over last week's mark. If present schedules remain in force, total production for March will be in the neighborhood of 365,000.

MARINE ENGINES Government, private and commercial orders are all steady, with an excellent outlook in the field of small craft as soon as the boating season opens.

AIRCRAFT ENGINES Output is reported steady by all major engine builders, with backlog of orders still mounting.

This summary is based on confidential information of current actual production rates from leading producers in each field covered. Staff members in Detroit, Chicago, New York and Philadelphia collect the basic information, in all cases from official factory sources.

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Successful ASTE Exhibition Attracts More Than 50,000

Exhibitors Number 253, Exceeding Last Year's Total by More Than 50 Per Cent

Profiting by the experience of last year, the second Machine and Tool Progress Exhibition of the American Society of Tool Engineers marked a great improvement over the very successful maiden show initiated in 1938. The present show boasts 253 exhibitors, exceeding last years' total by more than 50 per cent. Show space was much more generous this year, affording larger booths wider aisles, and better opportunity to observe the manifold activity. First day's attendance was 1400, grew to 6400 on Wednesday, promised to eclipse early estimates of total attendance of 50,000 for the week.

Scholarly discussion of the effect of the machine on our social system by able economist, Dr. Harold G. Moulton, president, Brookings Institution, was the high spot of the ASTE preview banquet. Scope of his study is evident from the title of the talk, "How has the development of the machine affected our standard of living and employment."

Major part of the presentation was aimed at providing historical and statistical evidence that technical progress, modernization and mechanization have upped the standard of living and have vastly increased employment and work opportunities. One cogent example is given here.

Dr. Moulton took the case of a promi-

(*Turn to page* 359, *please*)

American Motor Boat Exports Totaled $3,670,336 in 1938

Record Number of Outboard Motors Sent Abroad Bettered 1929 Mark of 11,321

Canada, Venezuela and Great Britain ranked as the leading markets, in order named, for American motor boat exports during 1938, according to the National Association of Engine and Boat Manufacturers. The year's exports totaled 14,292 units valued at $3,670,336.

One record was set and the total value of the boats, marine engines and outboard motors sent abroad showed an increase although the volume was off 103 units. The 1937 exports totaled 14,395 units, valued at $3,482,185. The record was set up in the number of outboard motor exports which reached a new high of 11,392 units. The previous mark was 11,321 motors in 1929.

Canada's long retained position as the chief customer among the more than 100 countries that buy from the American motor boat industry went unchallenged as 1665 units valued at $606,700 were shipped across our northern border. Venezuela's imports were valued at $409,270 and Great Britain's at $246,078. Sweden, France, Australia, Colombia and Japan were other ranking markets.

Four hundred and twenty motor boats were sent abroad with Great Britain, Canada, Venezuela, France, Mexico, Bermuda, Colombia and Brazil the chief purchasers. Sweden, with 1669 bought the most outboard motors. Great Britain took 1340; Canada, 1264; Australia, 1006; France, 714, and Finland 695.

Canada, Japan, the Philippine Islands, Venezuela, Australia, Turkey were the leading importers of American Diesel and fuel oil marine engines, and inboard gasoline motors went in largest numbers to Great Britain, Canada, Sweden, France, Norway, Venezuela and Argentina. Total inboard marine engine exports were 2480.

Continental Motors Reports Improvement

Continental Motors Corp. has increased employment by 16 per cent within the past two weeks and has added a second shift at its Muskegon plant to take care of the increasing volume of releases, according to W. R. Angell, president.

"A month to month expansion of sales has been experienced since the start of our current fiscal year, Nov. 1, last," Mr. Angell stated. "December sales were up 22 per cent over November. January brought a further gain of 15 per cent, and February closed with an increase of 30 per cent over January."

"Orders on hand amount to $2,903,450.24 as of March 1," he added.

While sales in the first fiscal quarter ended Jan. 31, 1939, were up 28.6 per cent compared with a year ago, volume did not reach a profitable level, although net loss after depreciation of $73,846 for the period was reduced to $141,664 from $160,728 in first quarter of preceding fiscal year.

Diamond T Takes Over Pak-Age-Car

C. A. Tilt, president of the Diamond T Motor Car Co., announced this week that Diamond T has taken over the entire sales and service of the Pak-Age-Car house-to-house delivery truck. The redesigned and improved Diamond T Pak-Age-Car will continue to be manufactured in the Connersville, Ind., plant of the Pak-Age-Car Corp., but merchandising of the line will be handled by Diamond T and the Pak-Age-Car will be sold exclusively by the Diamond T dealer organization.

International

They Want to Fly

First to enroll in the National Defense Program calling for the training of 20,000 civilian pilots were these three students at Purdue University. They are, left to right, Emmet F. Hamer, of West Liberty, Ohio, Lloyd L. Treece, of West Lafayette, Ind., and Oscar A. Grab, of New Rochelle New York. Purdue was the first of 13 colleges selected by the New Civil Aeronautics Authority to actually get under way in this program. Flight training was launched at the University's airport in February.

Abstracts

Writing on "The Ignition Quality of Diesel Fuels," Dr. J. Riffkin states that there are at least four methods of assessing the ignition quality of such fuels on the basis of delay-period measurements. These are as follows:

1. Injection-advance angles are adjusted so that the measurable pressure rise begins in top dead center.
2. Injection advance angles are adjusted so that the pressure rise in the cylinder is a maximum at, say, 12 deg. past top dead center.
3. The same injection advance angle is maintained for all fuels.
4. All fuels are injected with the same advance angle and the compression ratio is varied to give a constant-delay period, with a measurable pressure rise in top dead center.

Method No. 3 has been used in work done on Gardner engines for an I.P.T. Panel, while method No. 4 was used with the C.F.R. engine. The two methods gave a fair correlation of cetane numbers, but the limits of error are ± 2 cetane numbers.

Dr. Riffkin reports some tests on a single-cylinder 4⅜ by 5¾-in. four-stroke Tangye engine running at 1200 r.p.m. under about 40 per cent full load. During the tests the quantity and temperature of the intake air and the temperatures of the cooling water at the inlet and outlet were held constant. Two different fuels were used, viz., the high-grade secondary reference fuel of the Technical Committee on Diesel Fuels of the Chemical Standardization Committee of the Institution of Petro-

leum Technologists, and a 40/60 blend by volume of the high and low grades of secondary reference fuels of that committee. The timing of the beginning of injection was varied and the ignition delay corresponding to each injection timing was measured. The 40/60 blend gave a minimum ignition delay of 11 deg. with injection at 5 deg. ahead of top dead center, the delay increasing to 15 deg. for 18 deg. injection advance and to 20.5 deg. for injection begin at 6 deg. past top dead center. With the high-grade reference fuel the minimum ignition delay was 6.5 deg., with injection begin at 5 deg. ahead of top center; it increased to 15 deg. for injection begin at 27.5 deg. ahead of top dead center and to 11 deg. for injection begin at 7.5 deg. past top dead center.

The article also gives test data on characteristics of various blends of I.P.T. high and low secondary reference fuels, in terms of ignition delay as obtained on the Tangye engine, spontaneous ignition temperature determined on a modified type of Moore apparatus, the viscosity-gravity index, the Diesel Index, and the aniline point. The viscosity-gravity index and the Diesel index are calculated from the kinematic viscosity and specific gravity and from the aniline point and the specific gravity of the fuel by well-known equations. It is shown that whereas the aniline point and the Diesel Index decrease in a substantially straight-line relation with the proportion of the high-grade reference fuel in the blend, the viscosity-gravity index increases in a straight line as the high-grade reference fuel in the blend decreases, and the delay period and the spontaneous ignition temperature also increase with a decrease in the high-grade reference fuel in the blend, but these two factors are represented by curves convex to the horizontal axis (fuel-blend proportions) instead of by straight lines.—*Engineering*, Jan. 6.

Chevrolet Sales About 30% Above Last Year

Nearly 30 per cent more new cars and trucks have been sold at retail by Chevrolet dealers in 1939, up to March 9, than in the same period of 1938. Exact figure given was 29.6 per cent, representing 102,699 units sold in 1939, as against 79,249 sold during the same period last year.

Sales for the last 10-day period of February totaled 17,138, an increase of 4129 units over the 13,009 sold last year in the same period. This represents an increase of 31.7 per cent.

Figures for the entire month of February show an increase of 27.4 per cent over February, 1938, with 50,766 units sold as against 39,849 last year, an increase of 10,917 units sold.

A total of 113,779 used cars were sold during the month, 42,255 units being sold during the final 10-day period.

Lightest

Said to be the lightest of its type and power in the world is this new airplane engine perfected at the Ranger Engineering Corp. plant at Farmingdale, Long Island, N. Y. The 12-cylinder-in-line, 500 hp. air-cooled engine is reported ready for production.

Sales and service manager William J. Carry (left) and Duncan B. Cox, vice-president and general manager, of the corporation are standing beside the new engine.

Acme

GM's E. W. Smith Stresses Need For Increasing Farm Exports

Says Domestic Market for Motor Cars Is Jeopardized by Lack of Foreign Demand for U.S. Farm Products

While the automobile industry is deeply concerned with maintaining and expanding the market for its product abroad, "it is even more deeply concerned in seeing the market maintained and expanded in foreign lands for the agricultural commodities that the farmer produces," said Edgar W. Smith, vice-president of General Motors Corp., in a talk recently broadcast over WGY in Schenectady, N. Y.

"If this statement sounds paradoxical," Mr. Smith added, "I have only to remind you that the number of motor vehicles sold in the agricultural areas of the United States is far greater than the number of vehicles sold in all of our export markets combined. We have no illusions, in the last analysis, as to where our greater interest lies. We want to see farm exports increased because we know that our domestic market for motorcars and other manufactured goods is definitely in jeopardy so long as a lack of foreign demand for American farm products keeps the American farmer from a full measure of prosperity.

"There are some who will say that there are other solutions to the farmer's problem than an increase in his export sales. I say in reply that these other solutions have been tried and that they have failed. I urge, therefore, that the farmer throw his whole weight behind the effort to expand his foreign markets as the one approach above all others that holds promise of success without attendant danger.

"The automobile industry has given the most consistent and the most vigorous support to the Reciprocal Trade Agreements program sponsored by Mr. Hull. We have given this support because we believe in the principle of a more abundant two-way flow of American trade with the rest of the world, and because we believe that tariff-making in the United States is a business problem which ought to be dealt with in a business-like way.

"I want to express again my conviction that agriculture and industry have a common stake in foreign trade which springs from the stake they hold as one in the domestic welfare. We can help ourselves and help each other best, I think, by giving united support to the cultivation of that 'extra business' we are seeking under the liberal principles of give and take for which our Secretary of State has always stood, and which have served us both so well."

New German Aviation Research Institute

A report from the office of the American Commercial Attache, Berlin, to the Department of Commerce, indicates that Braunschweig, Germany, has become the center of a large aeronautic research department. The purpose of the new institution is said to be to produce a body of technically-trained aeronautic specialists. The Department is divided into four institutes as follows: Institute for Aeronautic Construction, Institute for Aero-Motor Mechanics, Institute for Aerodynamics, and Institute for Aeronautical Surveying and Meteorology.

Acme

New Car Conditioning

In a building entirely separate from the production lines, Chevrolet operates this car conditioning department which takes the units after final assembly and inspection. Here the cars are conditioned for delivery. Details such as tire pressure, radiator anti-freeze, transmission and rear axle grease, motor oil, and ignition timing are thoroughly checked and adjusted for the locality to which the car is consigned. The photograph shows the car conditioning department at the Flint plant, where a staff of 70 trained mechanics turn out about 50 cars an hour.

FTC Calls Steel Industry's Price System "Monopolistic"

Commission Recommends Replacement of Present Basing Point Method by an F.O.B. Mill System

The belief in Washington is strong that the Temporary National Economic Committee will disregard the Federal Trade Commission recommendation that the basing point system in the steel industry be uprooted to give place to an f.o.b. mill system. The FTC did not, in its appearance before the committee, confine its attack to that industry alone but assailed the basing point system as a whole. It charged that because it develops identical delivered prices the system is monopolistic, a theory that is sharply disputed even within government bodies which are participating in the TNEC inquiry. They are resentful of the FTC manner and kind of presentation, holding that instead of submitting an unbiased case, it has prejudged issues which still are being studied. And clearly there are members of the committee who do not share the FTC views on the basing point system. Even if not approving of the system in its entirety, they do not accept the premise that it necessarily is a non-competitive system. Moreover, to tear up an established system, it is realized, would result in economic chaos, affecting not only the steel and its consuming industries and labor but all of the many basic industries using the system. Legislative attempts against the basing point previously have been considered. Invariably they were dropped.

Meanwhile the system through an evolutionary process under the spur of demand and supply has undergone a widespread change. Where heretofore there was only one or were only a few basing points, there are many. In steel the number has grown from one to some 80, so that the industry definitely operates under a multiple basing point system, and, as one prominent government economist has said, there is decidedly "multiple competition" in the industry. Further, not only has steel developed many basing points but it has largely wiped out differentials over Pittsburgh. In effect, even though prices are quoted on a delivered price basis, this means a modified f.o.b. mill pricing system, though opponents of the basing point system hotly argue to the contrary. FTC "experts" say the elimination of steel price differentials, had no effect on competition in the industry. It may be confidently expected that this and other FTC views will be sharply refuted when steel executives appear before the TNEC.

The end apparently sought by the FTC is f.o.b. pricing at point of production or assembly. Under this plan the automobile industry would be profoundly affected. Its present practice of quoting f.o.b. at points of manufacture apparently would have to be extended to points of assembly.

Comparison between the basing point system and the automobile pricing system developed at the TNEC steel hearing when Jerome Frank, a member of the Securities and Exchange Commission and of the TNEC, inquired of Dr. Frank A. Fetter, former Princeton University professor, who testified as an economist for the FTC, whether a purchaser buying a car which was assembled in Philadelphia, did not pay the f.o.b. Detroit price, plus freight from Detroit.

Dr. Fetter replied that that was his understanding.

Senator O'Mahoney, chairman of the TNEC, inquired whether there are many automobile assembly plants. A. F. Hinrichs, chief economist, Bureau of Labor Statistics, Department of Labor, representing the department on the TNEC, replied that "assembly plants are quite well scattered and becoming more so."

"And you think the basing point system is used with respect to automobiles?" Senator O'Mahoney asked Dr. Fetter.

"I think that certain elements of the basing point system practice are creeping into those industries that ship and assemble elsewhere," said Dr. Fetter. "It is only a very minor degree.

"For instance, some of the Detroit manufacturers or Michigan manufacturers have assembling plants on the Pacific Coast and it is evident that they are able to ship in a way to save $40 or $50 at least, I do not know how much more, over the all-rail freight in that way, and then they proceed to charge on the Pacific Coast on the basing point principle, of all-rail to various points on the Pacific Coast."

Willis J. Ballinger, economic adviser to the FTC, interrupted to pay tribute to the automobile industry as an outstanding example of the competitive system.

"Certainly the most amazing example of cheapness is the automobile industry, starting with cars costing $5,000 and $10,000 and now down to $450 by a competitive system," he said. "In other words that is the great argument for the competitive system, that if you give it a chance it may give you the cheapest prices you can possibly get."

Advertising

Guy Gundaker, manager of accessory sales, B. F. Goodrich Co., Akron, has been appointed resident manager of the company's New York World's Fair exhibit.

U. S. Rubber "Foam Sponge" up-

holstery material will be heavily promoted in a campaign announced this week. Campbell-Ewald is the agency.

The State of Maine has been added to the sales area of Sun Oil Co., Philadelphia. Roche, Williams & Cunnyngham is the agency.

Young & Rubicam has opened an office in San Francisco with Bryan Houstan, formerly of New York, as manager.

Addison F. Vars, president of Addison Vars, Inc., Buffalo agency, and a director of Sterling Engine Co., has joined Dillingham, Livermore & Durham, a new agency, as executive vice-president. He will keep his other positions, he announced. The New York office is at 745 Fifth Avenue.

A moving picture is a part of an elaborate promotion program announced by Esso Marketers. The Esso reporter will continue on the air in a new series. Marschalk & Pratt, Inc., is one of the agencies.

G. M. Basford Co. has been appointed by Chicago Pneumatic Tool Co. Trade journals will be used to merchandise aircraft tools and machinery, Diesel engines, and other products of the company.

Atlantic Refining Co. will sponsor 1842 baseball games this coming season over 39 stations along the eastern seaboard.

U. S. Rubber Granted More Time to Draft Reply to FTC Charges

Ourselves and Government—A Check List Of Federal Action Corrected to March 16

CIVIL AERONAUTICS AUTHORITY

The Senate on Tuesday confirmed the appointment of C. B. Allen, former aviation editor of the New York *Herald Tribune*, as the third member of the CAA's Air Safety Board. Mr. Allen, who is a licensed transport pilot, was appointed acting chief of the CAA's publicity and information division last September. President Roosevelt sent the appointment to the Senate last week.

FEDERAL TRADE COMMISSION

VS. GENERAL MOTORS CORP. Alleged false and misleading representation in advertising prices at which certain of their passenger cars are sold. Hearings resumed March 7 at Detroit. Trial examiner, John W. Addison; FTC attorney, James M. Hammond.

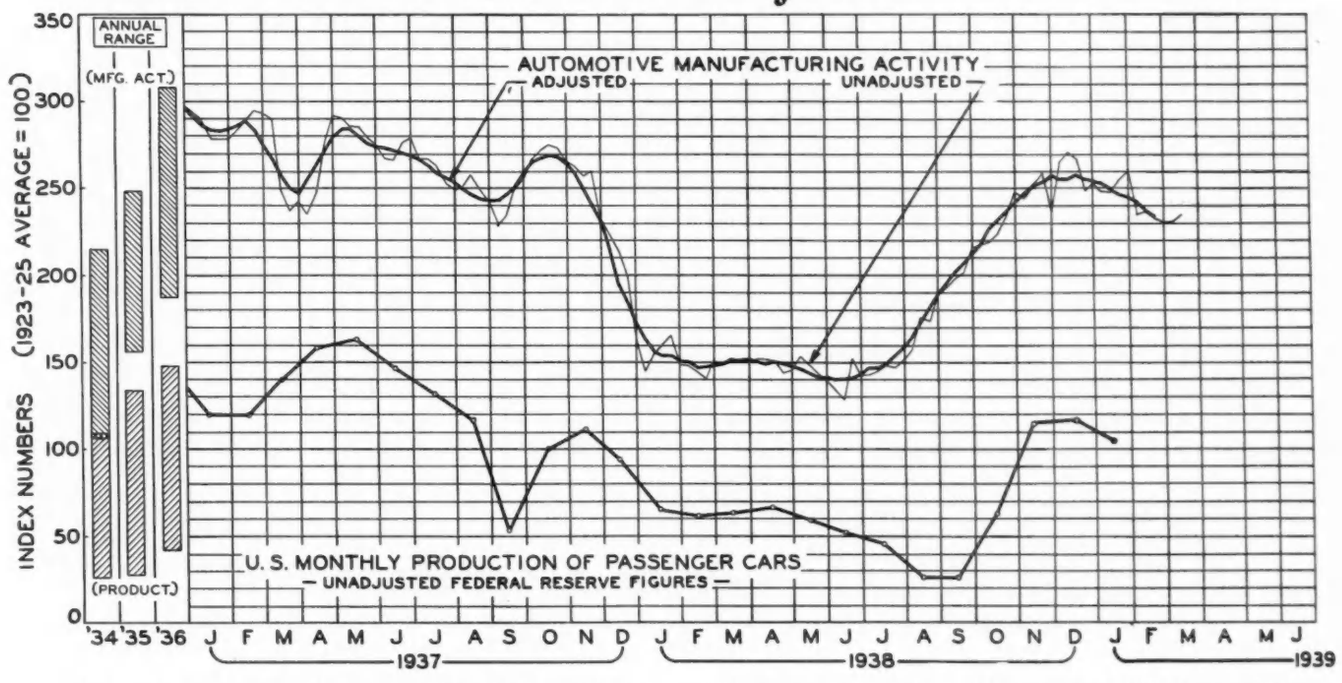
VS. GENERAL MOTORS. (No change.) The case, identified as the exclusive dealing case, involves the complaint that GM dealers allegedly are required to handle GM parts exclusively.

VS. UNITED STATES RUBBER CO. Respondents have asked for additional time to reply to the complaint and have been given until March 31. The FTC alleges unlawful price discrimination in the sale of tires in violation of the Robinson-Patman Act. Also involved is the United States Tire Dealers Corp., of New York, a subsidiary.

Crucible Steel To Make Ledloy

The Crucible Steel Co. of America has received license to manufacture Ledloy under Inland patents. Ledloy is the new lead-bearing steel developed and introduced by the Inland Steel Co. last year. A small amount of lead is added to the steel, so uniformly dispersed that it has no effect upon any physical properties, except to increase machineability. Machining speeds in production runs of hot rolled and cold finished bars can be increased 30 per cent to 100 per cent beyond the practical limits of ordinary steel, and tool life is extended 200 per cent or more.

Another Advance Lifts Unadjusted Index to 236



Preserving the upward swing started the preceding week, the unadjusted index for the week ended March 11 rose to 236, a five-point advance. The adjusted index, naturally, continued downward to 234, four points below the figure recorded previously. No additional Federal Reserve figures were available this week.

Evidences of Increased Activity Bolster the Outlook for Business

An Exclusive and Regular Weekly Feature Written by the Guarantee Trust Co., N. Y.

An improving business sentiment was bolstered last week by evidences of accelerated activity. *The Journal of Commerce* index of business for the week ended March 4, registering the largest weekly gain this year, rose to 86.3, as compared with 84.0 for the preceding week and 69.8 a year ago.

The upward trend of retail sales was reported as gathering momentum last week; and in the preceding week department store sales, according to the report of the board of governors of the Federal Reserve System, were 7 per cent greater than a year ago, as against a margin of 5 per cent below the corresponding 1938 figure reported for the week ended Feb. 25.

The production of electricity by the light and power industry in the week ended March 4, countering the usual seasonal trend, rose to a level of 10.2 per cent above last year's corresponding output, as compared with a similar margin of 9.6 per cent in the week before.

Railway freight loadings in the same period totaled 598,691 cars, 6.8 per cent more than in the preceding week and 8.3 per cent more than a year ago.

The average daily production of crude oil in the week ended March 4 was 3,314,850 barrels, or 14,000 barrels less than in the preceding week. Average daily requirements for March, as computed by the U. S. Bureau of Mines, are 3,312,950 barrels, as compared with 3,220,000 barrels last month.

The average daily production of soft coal in the same period was 1,420,000 tons, as compared with 1,453,000 tons in the week before and 1,069,000 tons a year ago.

Engineering construction awards in the week ended March 9 totaled $36,575,000, representing a decline of 57 per cent from the extraordinarily high figure for the preceding week, according to *Engineering News-Record*. The total for ten weeks this year shows a gain of 23 per cent over the corresponding 1938 contracts.

Cotton-mill activity increased more than seasonally in the week ended March 4; *The New York Times* index rose to 119.6, as compared with 116.4 for the preceding week and 88.7 a year ago.

Shipments of rayon filament yarn in the first two months of the year totaled 52,800,000 pounds, or 73 per cent more than in the like period last year, according to *The Rayon Organon*.

Professor Fisher's index of wholesale prices receded one fractional point to 80.2 in the week ended March 11.

Reserves of member banks of the Federal Reserve System increased $43,339,000 in the week ended March 8. Estimated excess reserves rose $30,000,000 to a total of $3,410,000,000.

GM-Cornell Index At 61.1, March 4

The General Motors-Cornell World Price Index of 40 basic commodities for the week ended March 4 was 61.1, an increase of 0.2 point over the previous week's figure. The United States index in gold also increased 0.2 point.

January Casing Shipments Eclipsed 1938 by 70%

Shipments of pneumatic casings during January reached the highest level since February, 1937, according to statistics issued by The Rubber Manufacturers Association, Inc. The number of units shipped amounted to 4,163,005 and, while this was less than 1 per cent above shipments in December, it was 70 per cent above January, 1938. Shipments of casings to automobile manufacturers, 1,685,190 units, reflected the slightly seasonal curtailment in that industry as between December and January but were over 1,000,000 units above original equipment shipments in January, 1938.

January replacement shipments, 2,353,822 units, were only slightly above December, but were 39 per cent above January, 1938.

Export sales for January amounted to 123,993 units, an increase of 26.3 per cent over December and were 29.7 per cent above January, 1938. Production of pneumatic casings amounted to 4,581,380 units, a decrease of 3.1 per cent under December, but were 70 per cent over January, 1938.

Pneumatic casings in the hands of manufacturers Jan. 31 were 8,932,245 units. This compares with 8,451,390 on hand Dec. 31, and 10,801,278 on hand Jan. 31, 1938.

Buick's February Sales Above 1938 by 35.7%

February deliveries of new Buick cars reported by dealers in the United States totaled 12,687 of which 5144 were sold in the last 10 days of the month. This compared with 9344 cars delivered in February last year, a gain of 35.7 per cent, and with 3315 units sold in the last 10 days of February a year ago, a gain of 55 per cent.

The record retail volume of 25,961 units for the first two months of this year compares with 18,783 cars sold in January and February last year, representing an increase of 6908 cars or 36.7 per cent.

Buick dealers sold 9693 used cars during the last 10 days of February, compared with 8973 in the previous period, and 8567 in the corresponding period of February last year, while used car stocks were lower than at this time a year ago.

Estimated Dealer Stocks of New Passenger Cars

1938	January	February	March	April	May	June
Production—U. S. Domestic Market†	130,273	119,896	153,316	160,028	140,239	123,333
Retail Sales—U. S.‡	126,442	120,348	188,325	193,392	187,306	155,811
Change in Inventory	+3,831	—452	—35,009	—33,364	—47,067	—32,478
Inventory, first of month	408,157	411,988	411,536	376,527	343,163	296,096
1938 (continued)	July	August	September	October	November	December
Production—U. S. Domestic Market†	96,975	53,955	60,177	171,371	295,366	305,900
Retail Sales—U. S.‡	153,426	123,711	90,629	*134,984	*241,009	*241,623
Change in Inventory	—56,451	—69,756	—30,452	+36,387	+54,357	+64,277
Inventory, first of month	263,618	207,167	137,411	106,959	*143,346	*197,703
1939	January	February	March	April	May	June
Production—U. S. Domestic Market†	263,232	.....	.....	.....	.....	.....
Retail Sales—U. S.‡	180,598	.....	.....	.....	.....	.....
Change in Inventory	+82,634	.....	.....	.....	.....	.....
Inventory, first of month	*261,980	344,614	.....	.....	.....	.....

†—U. S. Census Bureau. ‡Automobile Manufacturers Association *—Revised.

Booko

DEUTSCHE KRAFTFAHRTFORSCHUNG HEFT 19: SCHWINGUNGEN AUF DER ANSAUGSEITE VON ZWEITAKTMOTOREN MIT KURBELKASTENPUMPE (*Oscillations on the Inlet Side of Two-Stroke Engines with Crankcase Scavenging*), *by Dr-Ing. Ulrich Schmidt. Published by VDI-Verlag GmbH, Berlin NW7.*

The author of this research report previously had observed oscillations in the scavenging and charging pressure of a two-stroke engine and had concluded that these oscillations were due to the natural frequency of the system composed of the crankcase and the inlet passage. In the present report he determines this frequency analytically from the dimensions of the crankcase and the inlet passage and also gives the results of an experimental deter-

mination, the two values obtained being 180 and 183 cycles per second, respectively. In determining the frequency experimentally, the inlet to the crankcase was closed by a thin rubber membrane. An overpressure was produced in the crankcase through a small-bore passage in which there was a check valve at the entrance to the case. The over-pressure burst the rubber membrane, and the resulting pressure oscillations in the crankcase were recorded by means of a sensitive condenser-type pick-up device in the wall of the crankcase, a direct-current amplifier, and a cathode-ray tube.

Hopkins to Participate In Trade Assoc. Meeting

Participation by trade associations in such national problems as industrial mobilization in the event of war and steps toward preventing obstacles to the free flow of commerce which, it is claimed, is threatened by the raising of trade barriers by certain states, will be discussed at the spring meeting of the American Trade Association Executives to be held in Washington, May 1 and 2. The control of industrial statistics by governmental sources also will be considered.

Sharing interest with these program topics will be the presence of Secretary of Commerce Harry L. Hopkins, who, as chairman of the association's committee of award, will present to the winning trade association the bronze medallion bestowed each year in recognition of meritorious services.

Ford Counsel Asks NLRB to Reopen Case

Counsel for the Ford Motor Co. asked the National Labor Relations Board on Monday to reopen the case involving the company's Dearborn, Mich., plant to allow introduction of new evidence in the light of the recent Supreme Court decision on the sitdown strike.

Because of the decision in the Fansteel (sitdown) case, the Ford attorney told the NLRB that it is unjustified to assume that actions taken by Ford, and under scrutiny of the labor board, were designed to interfere with "legal" union activities. These actions were defended as justified in view of "the situation prevailing in Michigan which, the Ford attorneys said, were "compelling grounds to prepare to use force in a future situation"—the possibility of "an attempt by the UAWA to inaugurate a sitdown strike at respondent's plant."

The petition added:

"Respondents therefore made preparations to prevent such a seizure of its plant, the number of service men stationed at each gate was increased, several of the gates ordinarily open every day, were locked and others were kept in such a position that they could be locked in short notice."

Globe

Liquid Cooled

Curtiss XP pursuit plane powered with the latest V-type liquid cooled Allison engine. The plane shown here is the first powered with a liquid cooled engine to be accepted by the United States Army.

Prospects for Amending Labor Relations Act Held Favorable

Appears to Be No Chance for the Repeal Bill Proposed by Representative Hoffman

With the American Federation of Labor leading the drive, prospects for amending the National Labor Relations Act at the present session of Congress are generally held to be favorable. This view prevails despite reports that the Administration has quietly joined CIO opposition to any changes in the law, and regardless of the outcome of the AFL-CIO peace negotiations. Impetus to the movement for amending the act has made headway with the evident trend in Congress toward cultivating the conservative labor vote as represented by the AFL as contrasted with the more radical labor vote as represented by the CIO. Also the demand of business for modification of the act is a moving force that coincides with the rising sentiment in Congress to "appease" business.

There is not held to be any chance at all, however, of repeal of the National Labor Relations Act. A bill proposing repeal of the act and setting up new legislation has been introduced by Representative Clare E. Hoffman, Republican, of Michigan. The Hoffman bill probably will receive no consideration in committee, much less reported to the House, despite its wide appeal to business. Both labor organizations are strongly opposed to it. Mr. Hoffman, bitter foe of the CIO, said the bill had been written after careful study of various court decisions, including the recent decision outlawing the sit-down strike. He said the bill is the answer to the AFL's demand for a pro-American type of measure in which fair rules and freedom for voluntary cooperation between employers and employes are not interfered with. Nevertheless the measure has features which run counter to AFL's principles, as, for example, provision barring the check off except in cases where it has been authorized by the individual employes. It also throws safeguards around employers, as well as employes, which would meet labor opposition. Labor organizations also affect to see in the bill an attempt to encourage so-called company unions. It would permit employers to donate the use of premises, lighting and heating for union meetings without being held guilty of fostering company unions.

The bill provides it shall be an unfair labor practice for any person to threaten, restrain or coerce employes, who under the terms of the act are declared to have the right "to form, join or not to join a labor organization."

It would be an unfair labor practice for any person to dominate or interfere by threat, restraint or coercion, with the formation or administration of any labor organization or for any employer to encourage or discourage membership in any labor organization.

The bill would create a new National Labor Relations Board of three members to be appointed by the President,

(*Turn to page* 361, *please*)

Acme

Speed—330 M.P.H.

Shrouded in secrecy since its construction started more than a year ago, the new Martin attack bomber is shown before taking off on its first test flight on March 13 at Baltimore, Md., preparatory to entering the Army competition for fighting craft. It is understood that the two-engined, all-metal monoplane has a speed of 330 m.p.h. and can carry more than 1000 lb. of explosives. Its wing spread is said to be 80 ft.

Strength of Two UAW Factions Remains an "Unknown Quantity"

Cleveland Convention of Group Affiliated With CIO Is Expected to Clarify Situation

With actual strength of the contending factions in the United Automobile Workers Union still somewhat beclouded by claims and counter-claims issued by the rival groups it is expected that the convention of the UAW faction still affiliated with the CIO, scheduled to open in Cleveland on March 27, may throw a little more light on the situation.

As things now stand the Homer Martin group is definitely an independent union using the UAW name as does its opposition. The Martin union has possession of the original UAW headquarters offices in Detroit and many of the union records, while his opposition controls the mailing list used for distributing the union newspaper, the *United Automobile Worker*. Both factions are publishing newspapers under that name. Each is suing the other in the Detroit courts for the right to control union properties and until a court decision is reached their final disposition will remain in doubt. The cases have been combined by the court but have been subjected to several postponements, the latest coming this week although it was possible that hearings might begin toward the end of the week.

Martin's union has announced that it will not issue charters to groups of members in plants already chartered until after the court decision, with the exception that individual plants withdrawing from locals representing a number of plants will be chartered. Officers of such groups will be considered temporary until after the court decision.

Impeachment of Martin as president and a member of the UAW by the CIO faction became a mere formality in Cleveland on March 11. Martin did not appear and he was fired on 15 separate counts, chief of which were charges that he had conspired with officials of the Ford Motor Co. to betray the union, that he had attacked and slandered John L. Lewis and other CIO leaders, revealed confidential union matters to its enemies, and organized secret caucases to defeat the membership's desire to remain in the CIO.

Calendar

Conventions and Meetings

SAE National Aeronautic Meeting, Washington .....March 16-17
The National Battery Manufacturers Association, Spring Convention, The Greenbrier Hotel, White Sulphur Springs, West Virginia .....May 11-12
American Foundrymen's Association, Forty-third Annual Convention, Cincinnati .....May 15-18
SAE World Automotive Engineering Congress .....May 22-June 8
Automotive Engine Rebuilders Association, Seventeenth Annual Convention, Baltimore, Md. .....July 5-7

Shows at Home and Abroad

Yugoslavia, Belgrade, Automobile Salon .....April 1-8
Great Britain, London, Automobile Show .....Oct. 12-21
Italy, Milan, Automobile Salon, Oct. 25 to Nov. 11
International Automobile, Motorcycle and Motor Boat Show, Budapest, Oct. 27 to Nov. 6
Great Britain, London, Commercial Automobile Transportation Show, Nov. 2-11
Great Britain, Glasgow, Scotch Automobile Show .....Nov. 10-18

Maritime Commission Asks For Trade-In Allowances

The Maritime Commission took a page out of the experience of the automobile industry this week and proposed that Congress pass legislation permitting it to make trade-in allowances on old ships for the construction of new ones.

In a move to rehabilitate coastwise and intercoastal shipping, the Commission denied that there was anything novel about the idea and pointed out that 87.9 per cent of all new car sales last year involved trade-ins. Other factors on which the replacement program depends, according to the Commission, include greater cooperation between water and rail carriers and increased revenues from increased volume, higher rates, or both.

The report said that in the interest of an efficient, stable and profitable transportation structure, the fullest cooperation should exist between the industry, the railroads, motor transport companies and the Federal Government.

Perfect Circle Will Pay 50-Cent Dividend

The regular quarterly cash dividend of 50 cents per share on 162,500 shares of common stock outstanding was declared March 11 by the Perfect Circle Co. The dividend is payable April 1, 1939, to stock of record March 22, 1939.

Goodrich Announces Regular Dividend

Declaration of the regular dividend of $1.25 a share on the $5 cumulative preferred stock of the B. F. Goodrich Co. for the first quarter of 1939 was announced this week following a meeting of the board of directors. Directors also declared the dividend of $1.25 for the third quarter of 1938, thus eliminating all arrears on the preferred stock. Both dividends are payable March 31, 1939, to stockholders of record March 24.

The last previous payment on the preferred stock was $2.50 on Dec. 31, 1938, representing the dividend for the fourth quarter of 1938 and the dividend for the second quarter of 1938, then in arrears.

Houdaille-Hershey Reports 1938 Income of $588,230

Houdaille-Hershey Corp. and its subsidiary companies report a consolidated income, after all deductions, of $588,230 for the year ended Dec. 31, 1938. These earnings are equivalent to $3.38 per share on 174,000 shares of Class A stock outstanding on this date. After allowing for the regular annual dividend requirements of $2.50 per share

$3,646,754 for Safety

General Motors and its operating divisions throughout the United States spent $3,646,754 to protect the health and safety of its 125,836 factory workers on the job during 1938, according to figures just released by the corporation.

This expenditure, which amounted to approximately $29 for each of these employes, was for plant and equipment improvements to provide healthful and safe working conditions, medical salaries and supplies, hospitalization, physical examinations and miscellaneous medical and safety activities to safeguard employes.

Expenditures made for safety of factory workers on the job resulted in the best safety year in General Motors history last year and the fifth consecutive year of safety improvement.

on the Class A stock, these earnings amounted to approximately 20 cents per share on 785,057 shares of Class B stock.

Crude Rubber Consumption Decreased in Feb. 8.4%

Consumption of crude rubber by manufacturers in the United States during the month of February, 1939, is estimated to be 42,365 long tons, which compares with 46,234 long tons during January, 1939. February consumption shows a decrease of 8.4 per cent under January but is 77.5 per cent over February a year ago, according to statistics released by the Rubber Manufacturers Association, Inc. Consumption for February, 1938, was 23,868 long tons.

Men

Elwin M. Strickland has been placed in charge of the new branch office in Detroit recently opened by McKenna Metals Co., Latrobe, Pa., manufacturers of Kennametal tools and blanks for steel and metal cutting. Address of the new office is 142 Lothrop Bldg., 7376 Grand River Ave.

N. E. Malone, former sales promotion manager of the Goodyear Tire and Rubber Co., has been appointed advertising manager of the Seiberling Rubber Co., Arkon, Ohio. Mr. Malone fills the position left vacant by the resignation of John H. Bunting, who is now president and general manager of Akron Aircraft, Inc.

George B. Albrecht has been named general manager of the Nash Philadelphia Co., factory distributing branch of Nash Motors division, Nash-Kelvinator Corp.

ASTE Convention

(*Continued from page* 351)

nent organization which began business in 1870, employing 300 people. At the time, the work week was 60 hours, average weekly wage, $9.60, average annual wage, $465. Sales volume was about $1550 per worker. By 1908 sales had expanded to the extent that employment rose to 3000. The work remained at 60 hours but annual wage increased to $624 on the average. With no sensible improvement in technology the average sales volume per employe increased only moderately to $1986.

Twenty-eight years later, in 1936, taking advantage of modernization and improvements in machinery, the annual sales volume rose to $30,000,000 with employment upped to 7300 workers. Work week dropped to 40 hours while annual wages went up to $1698 on the average. Under these circumstances, the sales volume per employe increased to $9175.

The speaker drew upon a vast store of economic statistics to demonstrate that technical progress alone is responsible for wide employment, increased work opportunities. He pointed out that at this critical period in our political economy there is an immediate need for close cooperation between government and industry, and emphasized that only this liaison would break the present dam to a free release of private capital for productive enterprise and needed modernization.

Dr. Moulton concluded by stating three cardinal principles which, alone, would promote business progress at the present time:

1. An increase in efficiency of production through modernization and accelerated technical progress;

2. Appreciation by industry that the benefits of improved productivity must be immediately and widely disseminated through the medium of lower prices, higher wages;

3. That cooperative effort must be made to increase capacity to consume before effecting increased capacity to produce.

Preceding this talk, Prof. John Younger presented the preliminary report of the ASTE fact-finding committee studying the effect of the machine on employment and standard of living. The report is based entirely upon case studies from current literature and public addresses, all leading to the conclusion that machines and tools create employment. It poses frankly the problem of the small percentage of gainfully employed people who are temporarily or permanently displaced through improved techniques. The conclusion is that "we must go ahead with new machines but we must plan for and make provision for the displaced workers."

The preliminary report is but a stepping stone to a comprehensive study of the situation which will be carried on from this point.

Among the outstanding men at the speakers' table were K. T. Keller, Alvan Macauley, Nicholas Dreystadt, W. B. Stout. Clayton Hill, Murray Body Corp., was toastmaster.

W. B. Stout, president Stout Engineering laboratories, was principal speaker at the ASTE banquet, his topic being the engineer's contribution to civilization and progress. His text was that in the future management must give attention to a balance between the progress and research, development of new things with great rapidity, and the investment in tooling so as to prevent the freezing of design beyond its commercial usefulness. Undoubtedly, said Stout, future motor cars will be laid out with less die and tool cost, for simpler forms, permitting the production of low cost transportation in moderate quantity, a tool cost not to exceed $100 per car. The speaker visualized the tool engineer and production research man as the key men in the technical progress of the future, since more efficient tooling will bring the cost of products of development within the reach of the mass of the public.

Production

(*Continued from page* 351)

maintained throughout the winter months.

Out of the current week's total, General Motors divisions were expected to account for approximately 35,400 cars and trucks followed by Ford divisions with more than 18,000 and Chrysler divisions with approximately 18,000. Nash and Studebaker were practically even with schedules calling for 2050 and 2068 units, respectively, with Hudson only slightly behind with 1500.

An indication of the efforts that are being made to gear production to sales may be found in the first sales reports that have come in covering the first 10 days of March. With production running approximately 53 per cent ahead of last March, sales are running over 60 per cent ahead. Oldsmobile's first 10-day sales in March were 68 per cent ahead of last year and 37 per cent ahead of the last 10 days in February. Cadillac-LaSalle sales during the first 10 days of March were 64 per cent ahead of last year and 20 per cent ahead of the first 10 days in February, and Pontiac's first 10 days' sales were 61 per cent ahead of last year and 36 per cent ahead of the same period in February.—J. A. L.

John H. Teetor

John H. Teetor, former president and one of the founders of the Perfect Circle Piston Ring Co., died March 9. Mr. Teetor was 78 years old.

Increases Noted in Number of Steel Orders from Automobile Makers

Dismissal of Suit Seeking to Set Aside Wage Minimum Gives Rise to Rumors of Price Advance

A moderate increase in the number of orders received from automobile manufacturers and parts makers is noted by steel producers. Tonnages continue light and virtually all of the buying is for nearby requirements. Cutting in half of the minimum tonnages entitled to maximum quantity discounts on sheets, strip steel and carbon steel bars, announcement of which change came as part of the reaffirmation of current prices for second quarter shipment, is expected to usher in a period of more frequent placing of orders, which will permit steel mills to operate more advantageously while eliminating the penalizing of all but the very largest buyers.

Wire mills report booking more business for manufacturers' wire from automotive consumers than in some time. There has also been a pick-up in the placing of orders for alloy steel bars. Dismissal of the suit brought by seven of the smaller steel manufacturers in the East, who sought to have set aside the 62½ cents per hour wage minimum, resulted in forecasts of steel price increases for the third quarter even though the second quarter, for which unchanged prices were announced last week, has not yet gotten under way. Three months have come to be a long time to look ahead in the steel market, and much may happen in the meantime to alter conditions, but certain it is that the Walsh-Healey Act and the Federal Trade Commission's attitude with reference to the basing point system are the cause of much uneasiness in the steel market and make the price outlook three months hence one of great uncertainty.

Publication of the leading steel producer's report on last year's business, which showed a 45 per cent decline from the preceding year, shed considerable light on the conditions that brought about last year's short-lived price war. This week's rise in operations to 55.7 per cent of ingot capacity indicates remarkable recovery since the beginning of this year. Presence in the United States of a number of European steel scrap buyers may be in part responsible for the hardening of prices, but better domestic demand is at the bottom of climbing prices for one of the steel industry's most important raw materials.

Advices from Santiago, Chile, show that determined opposition has come to the fore against the proposed copper export tax, which for a time threatened to upset the copper market here. The market opened firmer this week with copper producers and custom smelters quoting spot electrolytic unchanged at 11¼ cents and little metal offered in the outside market at below 11 cents. The export price stood at 10.25 to 10.30 cents.

After dipping below 46 cents, spot Straits tin recovered lost ground and a small amount of business was done at that price. Whether the International Tin Committee will order a further cut in the production quotas or increase the buffer pool stock, to overcome the untoward discrepancy between demand and supply, remains to be seen. Meanwhile consumers are rather apathetic.

Following a buying flurry, which brought a $2 per ton price mark-up, the lead market slowed down. Storage battery manufacturers are covered for their March and the larger part of their April requirements.—W. C. H.

Olds Retail Sales Up 38% in February

Retail sales of Oldsmobile cars during February reached a total of 8466 units, an increase of more than 38 per cent over February of last year.

The combined January - February Oldsmobile sales figure of 18,729 cars exceeded by more than 6000 units the total for the same two months of 1938, an increase of more than 51 per cent. The sales totals were aided materially by a strong finish in February sales, the final 10-day period of the month showing 2826 cars sold at retail as compared with 2199 in the last 10 days of February, 1938.

As of the end of February, Oldsmobile dealers' inventories of used cars were 7000 lower than a year ago.

NADA Shifts Headquarters

Beginning March 20 the National Automobile Dealers Association will occupy new headquarters at 700 United Artists Building, 154 Bagley Avenue, Detroit, Mich.

February Registrations Estimated to Be 168,000

The nation's new passenger car registrations in February will total approximately 168,000, according to an estimate by R. L. Polk & Co., on the basis of registration returns from 12 states. The registrations in the United States in February, 1938, totalled only 120,359.

The 12 states on which February reports are complete show a total of 27,054 registrations. This represents a gain of 45.63 per cent over registrations in the same states in February of last year; and while it is 18.21 per cent under the 33,080 registrations in the same states in January, this decrease is slightly less than the average seasonal decline.

Total new truck registrations in the same 12 states in February total 5374, for an increase of 33.28 per cent over the 4032 registrations in February of last year. They are 11.76 per cent below the 6090 registrations in January, however.

On the basis of the 12-state total, the Polk Company estimates the nation's total new truck registrations for last month at 35,000.

Motoring en Masse

All records for collective mileage accumulation by American motorists probably will be shattered this summer as they take to the road in answer to the mass invitations issued by the New York and San Francisco world's fairs.

Survey indications are that about 9,000,000 motor cars carrying an average of 2.5 passengers each will roll toward New York and San Francisco. The average driving ing distance is estimated at 2000 miles for the round trip. The resulting total of 18,000,000,000 car miles or 45,000,000,000 passenger miles will represent a record in world motoring activities.

40 Years Ago

William N. Whipple, Locke, N. Y., is building a motor carriage to be propelled by one of his new "pulley" engines, as he terms it.

It is to be a four-wheeled carriage about the size of an ordinary democrat wagon, having a canopy top and seating four persons. The boiler and engine will be constructed as far as possible of aluminum and will weigh not to exceed 50 lb. Either soft coal or kerosene oil will be used as fuel, at an estimated expense of not to exceed 12 cents a day. The boiler is located in front of the driver's seat, and is covered with an aluminum casing with an air chamber between the boiler and the casing. The engine and water tank are under the rear seat and are connected with the boiler by tubes.

From *The Horseless Age, March.* 1899.

New Battery Corporation Organized by W. S. Perry

The Volta Battery Corp., Chicago, has been organized by Ward S. Perry, who headed the Vesta Battery Corp. from 1920 to 1930 and served as president of the National Battery Manufacturers Association from 1928 to 1930.

Mr. Perry will be president and trea-

surer of the new corporation, A. H. Townsend, vice-president and secretary, and Michael Sipich, vice-president and production manager. A complete line of starting and lighting batteries will be manufactured.

Labor Act

(*Continued from page* 357)

each to serve for a term of five years and one member of the board to represent the public. The board could not appoint any person to any position who is not at the time of appointment an American citizen. The limits and benefits of the bill are further restricted to American citizens by provisions in the bill making it mandatory before the board can issue an order certifying representatives for collective bargaining from any union, that the union must file with the board the names of all officers of the organization, with the certification that each is an American citizen.

Meanwhile, the AFL, and Government departments as well as business organizations, raised such strenuous objections to it, that Senate conferees have agreed to eliminate from the Air Corps expansion bill the CIO amendment which would deny Government orders to alleged violators of the Wagner Labor Act. The House conferees had insisted that the amendment be stricken from the bill.

Guinea Pigs

A step toward the day when passenger planes will fly the substratosphere was made recently at Minneapolis, Minn., when 10 civilian passengers, seated in a Northwest Airlines plane, slipped on masks and breathed a helium-oxygen mixture and cruised without discomfort at an altitude of 20,000 ft., with the outside temperature 32 degrees below zero. The gas apparatus was designed by staff members of the Mayo Clinic and was tested by them last summer, but this was its first test on civilian passengers.

Acme

Exports of Road-Making Equipment Leveled in '38

Exports of road-making and allied equipment leveled off during 1938 to a value of $35,895,000, as compared with the record figure of $34,550,000 in 1937, which represented a 75 per cent increase over 1936 exports, the Commerce Department reported this week. "A prominent factor in the strong recovery and maintenance of this trade is the importance of public agencies as buyers and users of road-making equipment," the Department said. "Governments throughout the world are renewing and actively carrying on depression-interrupted economic development progress in which road-building projects figure prominently."

Canada, the largest purchaser of American road-making and allied equipment, purchased $4,975,000 worth in 1938, or 14 per cent of the total exports. The Department reported, however, that an outstanding feature of the trade in recent years has been the greatly increased purchases of the African and Oceanic markets, principally South Africa, Australia, New Zealand, Algeria, Tunisia, Morocco, and Nigeria. These markets, it was reported, have taken an average of 32 per cent of this country's total road machinery exports since 1933 as compared with 18 per cent in the preceding nine years.

The 1938 shipments to Africa and Oceania were estimated at $10,744,000.

Bendix Aviation Income In 1938 Was $156,047

Net consolidated income of the Bendix Aviation Corp. and subsidiary companies for 1938 amounted to $156,047 after all charges, according to the corporation's annual report just issued. Total sales for the year declined to $30,893,546 from $40,594,629 in 1937. Net profits for the last half of 1938, as stated in the report, "were adversely affected by a change in the method of valuing inventories" which entailed a revised application of development, engineering and manufacturing expenses to cost of products sold and resulted in the inclusion in this year's cost of about $365,000 previously included as a part of the cost of inventories on hand.

Goodyear Statement Shows Earnings of $6,012,423

In its annual statement to stockholders, the Goodyear Tire & Rubber Co. reports net consolidated earnings for the year ended Dec. 31, 1938, of $6,012,423, after all charges. Consolidated net sales of the company and its subsidiaries for this period were $165,928,944, a decline of 23 per cent as compared with the 1937 figure of $216,174,513.

N.A.D.A. Plans Convention "Clinic" On Automobile Business Affairs

Dealers Association to Hold Its Twenty-second Annual Meeting in San Francisco, April 17-20

Members of the National Automobile Dealers Association attending their twenty-second annual convention in San Francisco, April 17-20, will devote the major part of their program to a "clinic" on the present condition of the automobile business.

Relations between the factories and dealers will be covered in prepared talks and discussion from the floor. The program will also include a session on problems of the metropolitan areas.

"Correction of our problems through mutual cooperation is one of the goals in our program for the year," explains President J. W. Roby of Shreveport, La. "As an outgrowth of a suggestion advanced last year by Alfred P. Sloan, Jr., of General Motors Corp., we have appointed a special committee on Commercial and Public Relations, composed of representative dealers in each line who will be available for conference and discussion purposes in connection with common industry problems."

Guest speaker at a banquet to be held April 19 will be W. E. Holler, general sales manager of the Chevrolet Motor division of General Motors Corp. An important speaker in general sessions will be Judge Wilbur M. Alter of Denver, who will discuss the recent decision of the NLRB arising out of a dispute between the Denver Automobile Dealers Association and the Mechanics Union.

Men and Machines

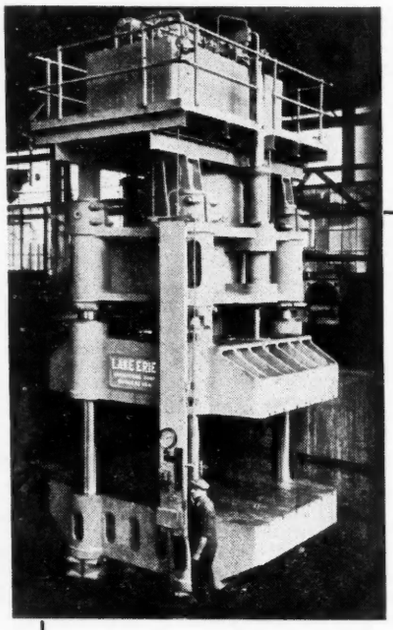
Machine Tool Orders Advanced Again in February

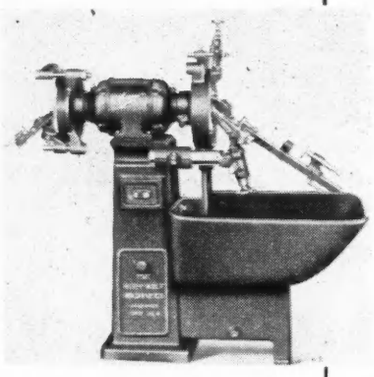
National Machine Tool Builders' Association Reports Increase in Its Index to 167, an Advance of 54.9 Points Since November

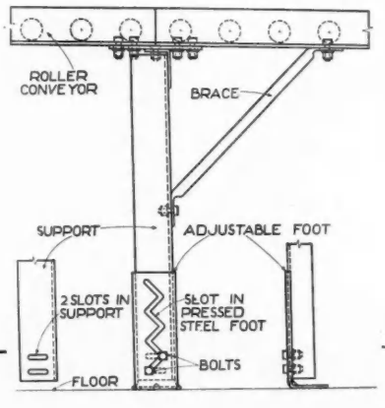
By H. E. BLANK, JR.

THIS week the National Machine Tool Builders' Association happily reported its index of machine tool orders for February at 167, an encouraging advance in a month that is seasonally low of 16.3 points above the January mark. Since November last the index has climbed 54.9 points and the steady upward march indicates the strength of current demand for machine tools. In February, domestic orders gained ground over foreign business, the latter holding around the same level as for the last six months. Says the association's secretary, "This is regarded throughout the industry as encouraging to the immediate outlook at home."

Further encouragement for the "outlook at home" may be read into comments made by Alfred P. Sloan in a message addressed to General Motors' stockholders on March 13. In the opinion of Mr. Sloan "America's production plant today is largely obsolete." He reasons that for several years the production of new equipment has been below normal. An important shortage, he claims, has resulted which reflects itself in a reduced efficiency of our production plants, because of the effect of normal depreciation as well as obsolescence resulting from technological improvement. To Mr. Sloan the answer is to be found in the investment of capital in the making of new and useful things, as well as in better instruments of production in order that present things may be made at a lower cost, sold at a lower price. "That," says GM's chairman, "is what is needed today to broaden the present recovery movement."







A 2500-ton press for the French Air Ministry (Above). New wet drill grinder offered in six models (Top right). Adjustable floor support for conveyors (right).

While Mr. Sloan has pioneered many original ideas in the industry, we suspect that with this one he mirrors the thinking of many other manufacturers. In line with this, when the Gordian Knot that has bound business for nearly a decade is cut completely, there should be a flood of fresh orders for the equipment builders. And the latter, judging by the new developments and refinements introduced at the ASTE show in Detroit, will not be caught napping. There's a final report of the ASTE show and convention elsewhere in this issue, and much of the equipment shown for the first time at Detroit's huge convention hall was described last week in an article appended to *Men and Machines.*

One of the many interesting new machines brought to our attention in recent weeks and not previously described is a wet drill grinder offered in six different models by the Hisey-Wolf Machine Co., Cincinnati, Ohio. On the model shown on this page the large drill holder on the right provides adjustment for grinding cutting clearance (angle at circumference). The point angle can be varied from 37 deg. to 70 deg. This set-up permits the grinding of straight or taper shank drills with 2, 3 or 4 flutes, also flat or chucking drills or flat twisted drills and drills for oversized shanks.

A small drill holder for straight or taper shank twist drills from No. 60

(*Turn to page* 379, *please*)

Just Among Ourselves

More Competition In Low-Price Field

ON Monday, March 13, Studebaker introduced its new "Champion" to dealers, fleet operators and the press of the New York metropolitan area. It was an especially interesting event for many reasons, one of which was that it is seldom in these years that a new car announcement is made during a period when everybody's announcements aren't popping out from behind the nearest bush. The pre-show announcement season around Detroit is a refined form of lunacy which takes years off the lives of those who must participate from either side of the fence. One party succeeds another so rapidly that the events of a week become a sort of blurry nightmare.

In the case of the Studebaker announcement there was time enough for the program to sink in and make an impression which stands the light of several tomorrows. The overwhelming impression which came out of the whole business, and which remains, is of the courage of Studebaker management, which carried on for four years an engineering program for the development of the new car. The engineering results seem to justify the time and money involved (it will be another week or so before the complete details of the new automobile can be released). But even above this is the fact that the fight for a profitable portion of the low priced car market will be carried aggressively into the laps of the Big Three.

The new car will be presented to the public on a point-by-point comparison of specifications with other cars in the low-price class. But in addition to this, the whole philosophy of manufacturing of the big fellows will be challenged aggressively in Studebaker promotion.

This fact brings out no evidences of panic on the part of the Chevrolet, Ford, and Plymouth high command, but a good many of their dealers in communities where Studebaker is already in a strong position are cocking a wary eye at the newcomer.

Everything considered, we feel that Studebaker's fight for a place in the mass market will be one of the most interesting events in this year's automotive cosmos. The Champion will be backed by one of the best integrated merchandising programs we have ever seen. Newspapers, magazines, radio and industrial films will carry the story to the public, beginning about the middle of April. The first million dollars to be expended on the program will be spent in about 14 weeks, and the copy, both visual and audible, packs a terrific wallop.

So, David is going after three Goliaths, with no murderous intent, but resolved to commit a little effective mayhem. David's (or shall we say Paul Hoffman's) slingshot is well implemented. The aim looks good. We're just waiting for the sound of the impact in order to judge the effect of the shot.

Driving, a Test of Nerves

THE results of a very interesting symposium on "Comfort in Travel" have come out of England via the March *Journal* of the Institution of Automobile Engineers. The elements which affect the comfort of people traveling by road, by railroad, and by air were analyzed in three papers by leading authorities.

Sidney E. Garcke, executive director of the British Electric Traction Co., Ltd., presented the comfort considerations involved in travel on the road. There are very many things in his paper worthy of quotation. We select his remarks on a problem which is just beginning to attract wide attention in this country. **Quoting:**

"It must be remembered that a large proportion of those traveling in private motor vehicles are drivers. The discomfort due to nervous reaction imposed upon a driver by the presence on the road not only of many signals, but of advertisements, lights, and other contrivances, readily confused with official signs, is very real. Such signs are now greatly on the increase, and will have to be controlled. Indeed, it might fairly be stated that even official signs, signals, warnings and markings on the road surface are too many, and make a journey a test of nerves, even for the experienced driver."

All of which is too sadly true even in the United States. The American Automobile Association has begun to fight for state laws and local ordinances controlling the use of billboards and other unsightly (and sometimes dangerous) jetsam along the trunk highways. Right now is a good time to make a choice between driving in the future on roads which resemble paradise or a pigsty. We hope the AAA will continue its battle for unemcumbered rights of way, and that it will get a lot of help from other automotive organizations.

—HERBERT HOSKING

THE CHILTON ROUND TABLE

In order to give readers of AUTOMOTIVE INDUSTRIES a clue to certain merchandising and service aspects of the automotive industry which are normally outside the scope of an industrial publication, we present herewith excerpts from the March issues of the four other magazines published by the Automotive Division of the Chilton Co.

FROM AUTOMOBILE TRADE JOURNAL

No longer the subject of private gossip, finance "packs," unwarranted, unfair and allegedly dishonest overcharges in financing automobiles, is openly discussed whenever and wherever dealers and finance company representatives meet.

There seems to be a universal urge to curb such practices. To be sure, much of this is plain hot atmosphere. One dealer association offered to pool a large chunk of cash with a group of finance companies to stamp out the growth in its state—and found no takers.

On the other hand there are those who will cooperate and who do believe that it is imperative that action be taken now—in order that public opinion of car dealers as a whole shall not be lowered by the actions of a few.

FROM COMMERCIAL CAR JOURNAL

One of CCJ's agents got into a hall room discussion one night with a keen and well informed observer of the automotive industry who opined that next year the models are going to be different. He predicts a lot of changes and bases his prediction on the fact that full crews of tool makers are working full time and that in some cases there is actually a shortage of this type of craftsman. His intimation was that more than normal tool activity always presages drastic changes.

FROM MOTOR WORLD WHOLESALE

If more jobbers could sit at purchasing agents' desks and interview their own salesmen, they would learn a lot they may not know at present. Some would be shocked at

(Turn to page 380, please)

The Manufacture

So exacting are the demands on aircraft engine bearings, heavy-duty tractor bearings and even on brass, bronze and aluminum castings for certain structural and dynamic purposes that manufacturers of such products must now employ the finest and latest type of scientific equipment in routine production processes. To this end the Michigan Smelting and Refining Division of the Bohn Aluminum & Brass Corp., has just completed making a number of interesting revisions in its laboratory incorporating much new equipment and various refinements in processing techniques. The changes apply to the ingot as well as fabricated units.

Ultimate purpose of the equipment is—in the case of the manufacture of ingot—to minimize impurities and to secure uniformity of chemical, physical and structural properties. In the case of semi-finished and finished products the purposes of the equipment are to eliminate imperfections and to reduce to a minimum rejections due to flaws and other difficulties; also, to detect flaws or impurities in the early stages of refining or manufacture so as to eliminate useless but expensive operations.

Among the equipment recently installed in this laboratory is a 70,000 to 150,000 lb. reverberatory furnace for the production of brass ingot. Speedy and highly accurate analytical methods are required for checking the composition and purity of each melt while held in the molten state. For this purpose a routine spectrographic control method is being developed which gives a complete and accurate analysis of the impurities in the melt in a maximum period of 30 min. The spectrograph has been used in the Michigan Smelting laboratory for several years during which time it has proven its applicability to both experimental and routine control work. For the present problem the laboratory has installed a Hilger Microphotometer, the use of which greatly increases the speed and accuracy of spectrographic analyses and places them on a routine control basis.

The general principle of the operation of the microphotometer is as follows: A beam of light of constant intensity passes through the spectrographic plate which may be moved slowly so that various spectral lines may be brought into the path of the light beam. The transmitted light of varying intensity, depending upon the density of the spectral lines being measured, is then focused upon the slit of a delicate photo-electric cell which is connected with a galvanometer. The deflections of the

Plate 1—Spectra of cadmium with lead content increasing from 0.000 to 0.50 per cent

Automotive Materials 25

# of Aircraft Engine Bearings

requires close laboratory supervision to insure uniformity of materials and obviate flaws or impurities

Left—Dr. Frances Lamb operating spectroscope at laboratory of Michigan Smelting and Refining Division of Bohn Aluminum and Brass Corporation

Right—Analyzing spectrographic plate by use of microphotometer. At the rear is shown assembly of galvanometer in "Julius Suspension." By this method vibration is eliminated by shock absorbers in oil and there is a glass housing for freedom from dust. Dials are for checking current for lamp which supplies light of uniform intensity. Light beam passes through plate in turn being focussed on photoelectric cell which in turn gives relative galvanometer reading.

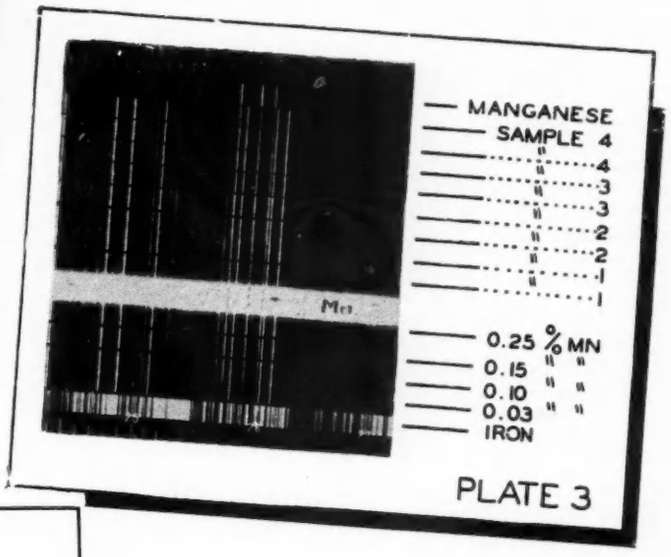


Plate 3—Typical central analysis of German silver extrusion billets for manganese

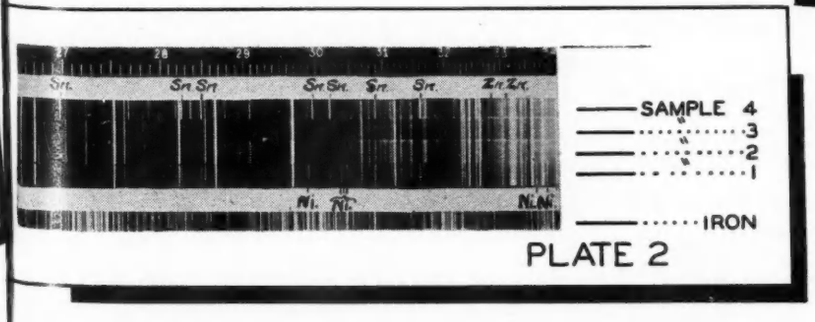
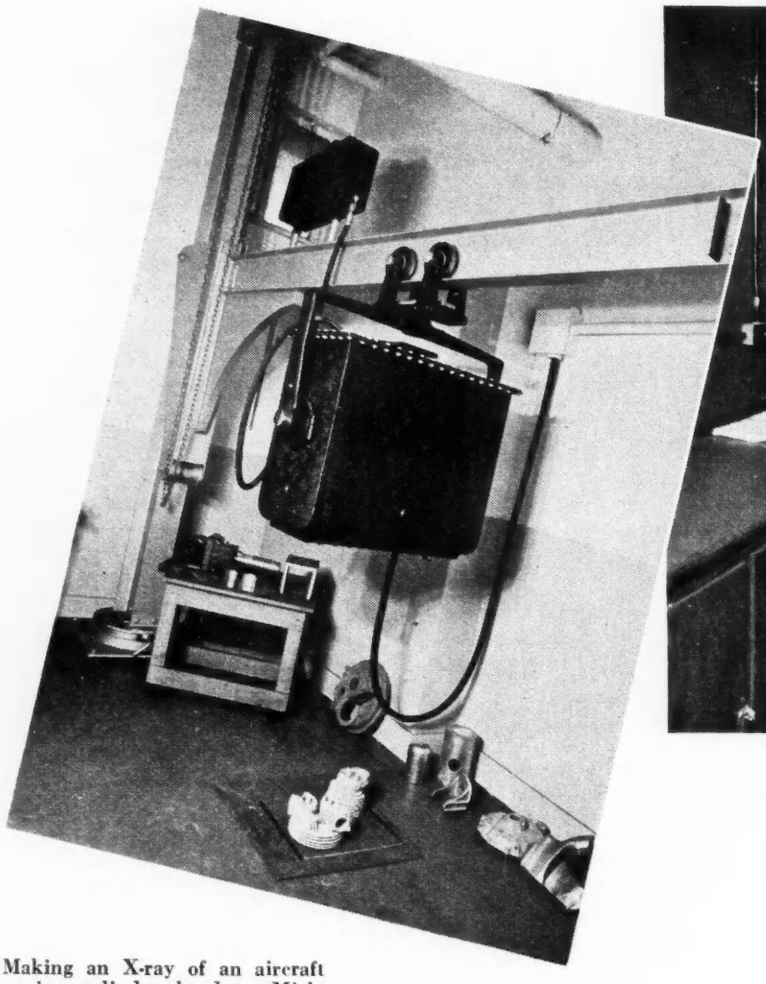
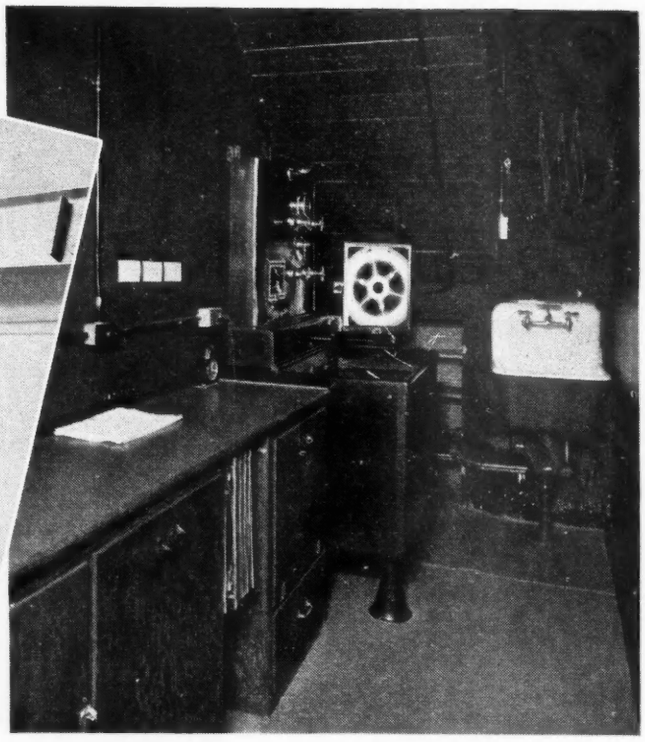


Plate 2—Examination of four samples of cadmium base bearing alloys for tin



Making an X-ray of an aircraft engine cylinder head at Michigan Smelting and Refining laboratory



X-ray film developing dark room showing temperature-controlled developing tank.

mirror of the galvanometer which are a function of the photo-electric current, the light intensity and the photographic density of the spectral lines, are then indicated by causing a beam of light to be reflected from the mirror on to a transparent scale.

By the use of this instrument the relative intensities of the spectral lines corresponding to the various impurities, such as iron, antimony, aluminum, silicon, nickel, manganese, arsenic, occurring in the spectra of the samples taken from the molten charge may be read as galvanometer deflections. These readings are then transferred to percentage impurities by referring to standard curves prepared from standard alloys having known percentages of impurities.

Another addition to the equipment of the production control laboratory is a General Electric 200,000 volt Oil Immersed Industrial X-Ray Unit, including a completely equipped dark room. Due to the fact that all materials absorb x-radiation to a different degree it is possible to make a photographic record of the internal condition of any material which will show the presence or lack of homogeneity within the material. In this way it is possible to show

Plant Handles Two Million Tons of Materials in Year

More than four billion pounds, or two million tons of materials, used in the manufacture of tires and 32,000 other rubber products by The B. F. Goodrich Co., were moved by 75 tractors and 600 trailers in the company's Akron plant last year, year-end figures show.

Among the materials handled were:

From 10 to 25 carloads of crude rubber, averaging 30 long tons a carload, or a maximum total of 1,680,000 lb. daily.

The equivalent of 53 thousand bales of cotton in the form of weftless tire cord, hose, yarn and fabrics, or about 22 million pounds, annually.

Two or three carloads of carbon black, maximum total of 195,000 lb. daily.

Approximately 400,000 lb. of pigments, exclusive of carbon black, daily.

Nearly 400,000 gallons of oil and solvents monthly.

About 215,000 lb. of paper, for packing of products and other uses, monthly.

Seventy carloads of wire beads for tires annually.

defects which may occur in metal such as shrinkage, cracks, piping, gas cavities and various inclusions.

Radiographic examination is being used as an aid in developing the casting technique, including location of gates, chills and risers. In addition to its use in the development of casting technique on all new castings produced in the various Bohn plants, radiographic inspection is also used as an occasional periodic check on castings taken at random from general production. A number of the more important castings such as aircraft and some automotive parts are each checked individually. One of the interesting applications of X-ray examination has been the inspection of copper-lead bearings for the presence of lead segregation.

The United States Government has specified X-ray examination of certain aircraft parts for military purposes. The addition of this X-ray machine which is now in routine use, coupled with the complete protection of ingot quality provides safeguards for uniformity and freedom from defects from the initial molten stage of the metal right through to the finished castings. Besides the units described there are also other devices now incorporated in the laboratory for special tests on particular products. New in the laboratory is a special calorimeter for thermal measurements, particularly having to do with heat transfer.

Automotive *Materials*

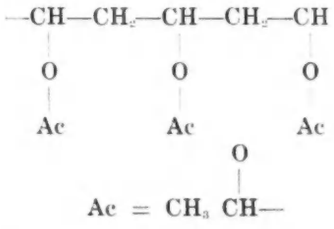
NEW DEVELOPMENTS

Synthetic Resin for Safety Glass

Advances made in plastics for safety glass were described in a talk recently delivered by J. M. DeBell, director of development, Plastics Division, Monsanto Chemical Co., Indian Orchard, Mass. Only five years ago cellulose acetate replaced the nitrate plastic in this application and, now, according to Mr. DeBell, a new synthetic resin type challenges the superiority of the cellulose acetate.

The newer synthetic resin plastic, in 60 per cent of the acetate thickness, is said to more than double the "toughness" of the safety glass, and at the same time eliminates cementing and edge sealing. It is based on vinyl acetal resins derived from vinyl acetate.

When acetylene is passed into acetic acid in the presence of mercury salts, it combines to form the unsaturate vinyl acetate. This is a volatile, mobile liquid, in appearance somewhat like the ethyl acetate used in lacquer. If peroxide oxidizing catalysts are added to it, however, and it is gently heated, it thickens rapidly, and after removal of any unpolymerized material, it finally becomes a tough glassy resin having a low melting point. This polymerization establishes a long polyvinyl chain in which the double bonds are lost, and which seems to consist of this structure



The appended acetate groups, without seriously disturbing the rest of the chain, can be reacted chemically. In the safety glass resins, a great majority of the acetate groups are replaced by hydroxyls from water and by acetals from various aldehydes. The resulting resin is a stiff, tough, glass clear thermoplastic, which on plasticization furnishes a plastic material of amazing rubberiness and toughness, which further does not become brittle at low temperatures, nor fluid at reasonably high temperatures. Its rubber-like stress strain diagram indicates that its atoms may not be arranged in straight chains, but perhaps rather occur in some sort of spiral arrangement. In any case, the physical properties are admirable for safety glass. The resins are protected by the patents of Shawinigan Chemicals, Ltd.

Means have been found by which this plastic can be produced continuously in sheet which shows variation of less than 0.0005 in. in thickness across its entire width. The impact strength of safety glass made from the plastic is judged by its support of ½ lb. and 2 lb. steel balls dropped from various heights; and it will be seen by inspection of the break test curves that the use of the plastic offers pronounced improvement over the safety glasses which have been proposed heretofore. Although its initial appearance has been in 0.015 in. thickness, it has been demonstrated that still greater impact strength can readily be obtained, if desired, by use of thicker material.

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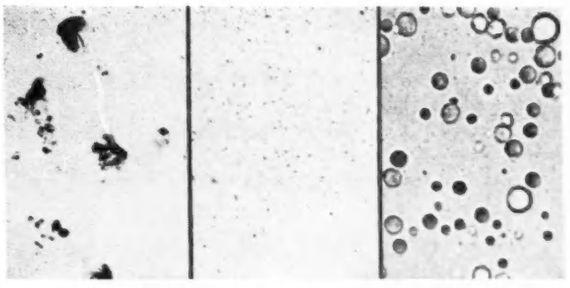


The particle size of the solids which together with water form milk, or the size of fine grains of face powder, are rather large compared to the particle size of the new "dag" colloidal graphite just introduced by Acheson.

Illustration 906 times actual size.

A Grease Solvent for Use on Metal Airplanes

The research laboratory of the Curran Chemical Corp., Malden, Mass., has developed a hydro-degreasing safety solvent to be used for degreasing and deoiling metal airplane fuselage and engine nacelles of aluminum skin construction. In addition to possessing good wetting out and solvent action upon heavy grease and carbon exhaust smut, this new solvent is said to have "automatic emulsifying" properties when it is associated with a substantial amount of water.

Practical tests made in the field show that large military or transport planes may be deoiled and degreased by spraying the under-fuselage and the engine nacelles with the solvent composition. Then the solvent is sluiced and washed away with a water hose which automatically emulsifies the grease and oil. The oils and dirt are removed in a milky "oil-in-water" type of emulsion which eliminates fire hazards and clogging of the sewer drains. It is stated that the solvent is safe for use on aluminum or magnesium alloys under all possible conditions and concentrations.

Acheson Offers New Graphite Lubricant

Colloidal graphite in a new form has just been introduced by Acheson Colloids Corp. The new product has particles so fine that it can be suspended in such volatile liquids as carbon tetrachloride, kerosene and other organic liquids. When suspended in such liquids it may be applied by brushing, spraying, or dipping. The liquid carrier then evaporates, leaving a dry-lubricant film of colloidal graphite deposited on the surface of the material. Under friction the fine particles of colloidal graphite are worked into the surface of the material, forming what is called a "graphoid" surface.

The particles of colloidal graphite in the new product are actually so small that many of them are invisible through a microscope. The new product is to be marketed in various grades, the "top" grade having a maximum particle size of less than four one hundred thousandths of an inch. (One micron, or 0.000039 in. is maximum particle size.)

Another characteristic of the new product is that it is far more resistant to the precipitating effect of acids and alkalis.

In addition to being able to provide stable suspensions of colloidal graphite in such volatile liquids as carbon tetrachloride and low viscosity liquids as kerosene and other organic liquids, the new "dag" is to be available also in such carriers as castor oil, glycerine, varnish, petroleum oil, etc.

A Transparent Protective Coating for Various Metals

A transparent protective metal coating which is said to withstand the action of sunlight, moisture and climatic changes has been announced by the Fales Chemical Co., New York. It is claimed that this coating — "Seal-Cote" — has been used successfully with copper, brass, bronze, steel and other metals and has preserved their original finish even when exposed to the weather for at least six months. It may be sprayed or brushed on by a simple technique.

New "High Speed" Synthetic Enamels

A new line of synthetic enamels, with very short baking schedules, has just been placed on the market by Maas & Waldstein Co., Newark, N. J.

These new finishes, which are known as "Polydur" enamels, were developed to enable manufacturers to speed up production by reducing the time needed for finishing their products.

Polydur enamels are said to set out of dust in a few minutes. Their baking schedules depend upon the temperature employed, but, at 325 deg. Fahr., they bake to a fine finish without discoloration in 15 min. The finish is claimed to be very durable, and resistant to marring, moisture, and ordinary household chemicals. Polydur finishes are supplied in white and all colors, for spraying or dipping.

Chemical Actions In Production of Plastics

In a paper contributed to a symposium on plastics at the semi-annual meeting of the Electrochemical Society in Rochester, N. Y., Dr. Gordon M. Kline of the National Bureau of Standards classified the various types of plastics and reviewed the chemical actions involved in their production.

Plastics, he said, can be classified on the basis of their chemical source into five principal groups, as follows: (1) Synthetic resins; (2) synthetic "lastics"; (3) plastics from natural resins or bituminous materials; (4) cellulose derivatives, and (5) protein plastics. The first group may be subdivided into several chemical types of resins as follows: (a) Phenolic-aldehydic; (b) amino-aldehydic; (c) hydroxy-carboxylic; (d) vinyl; (e) acrylic; (f) styrene, and (g) indene resins. The first three types comprise the so-called condensation resins and the remaining four the polymerization resins.

The synthetic lastics are a group of materials which are synthesized from small molecular units by reactions similar to those used in resin chemistry to build up macromolecules, but which have properties resembling more nearly those of rubber than those usually associated with the resinous state. The term "rubber," however, has become definitely identified with a commercial product of well-established chemical constitution. The word "lastics" has therefore been suggested by Ellis as a generic name for the class of substances which possess rubber-like properties, irrespective of chemical structure. Various minimum limits of extensibility have been suggested for substances to be classified as synthetic lastics. However, the chief industrial application of a borderline material will probably govern its classification as a synthetic resin or synthetic lastic by chemists and engineers.

The present commercial synthetic lastics are subdivided into three groups: (a) The polymers of butadiene and its derivatives; (b) organic polysulfides, and (c) miscellaneous elastic substances produced from isobutylene, styrene, and polyvinyl chloride plasticized with tricresyl phosphate. These synthetic lastics fill a definite need in industry for materials with many rubber-like properties but superior to rubber in resistance to oils, gasoline, various solvents, ozone, atmospheric oxygen, and heat. It has been predicted that the next 10 years will see just as remarkable an extension of types and applications of these synthetic lastics as took place in the second decade of synthetic resin production between 1920 and 1930.

The group of natural resinous and bituminous plastics includes the natural resins, such as shellac and resin, the bitumens, the resinous products derived from rubber by chlorination, hydrochlorination, and isomerization, and the plastic masses obtained by the chemical treatment of lignin. The cellulose derivatives are subclassified into (a) cellulose

(*Turn to page* 380, *please*)

Production Lines

Air Conditioned

Discussion of a paper on air conditioning by R. E. Gould, Frigidaire Div. of G.M., brought out some mighty valuable points. For example, it seems quite reasonable to assume that air conditioning—in its true technical sense—is a long way off so far as passenger cars are concerned. It is estimated that a normal four-door sedan will require a system capable of providing the equivalent of 100 pounds of ice per hour. A mechanical system having this capacity should weigh around 250 pounds. Both L. P. Saunders of Harrison Radiator, and Fred M. Young raised a point that we have stressed in these columns for some time—namely, the need for setting up standards for air conditioning. Such standards exist in the building codes of various communities and could be adapted for automotive purposes by cooperation with the A.S.H. & V.E.

Heat Prover

One of the larger oil companies gives us the details of an interesting service they render to users of its industrial lubricants. They have developed instrumentation called the "industrial heat prover," which measures accurately the percentage of free oxygen and combustibles present in exhaust gases, continuously and simultaneously. Thus is provided a measure of combustion efficiency of any industrial furnace, boiler, or engine. Too, the instrument is of value in metallurgical furnaces processing metals. Ask us about this service.

Stress—Strain

Of practical significance to engineers and designers is the first edition of the text—"Formulas for Stress and Strain," by Raymond J. Roark, professor of mechanics, University of Wisconsin, in the McGraw-Hill series of texts on product development. This book brings together between one set of covers the formulas, facts and principles in the field of strength of materials so essential in the precise methods of stress analysis required in modern engineering. High spotting by chapter headings, the text covers such topics as — definitions and symbols, fact and principles such as the behavior of bodies under stress, formulas and examples on tension, shear, combined stress, beams, torsion, columns, elastic stability, dynamic and temperature stresses. Text matter is supplemented by well chosen illustrations and a series of 19 tables, including the properties of engineering materials. The book runs some 326 pages including the index.

Play Ball

Annual Fisher body event, and one that we don't miss, is the showing of the American League baseball film, prior to the spring training season. This year the film commemorates the "First Century of Baseball," replete with scenes of past grandeur, bringing back the old-timers who made the game what it is today. What we are leading up to is the fact that the film is being made available, without charge save for transportation, to all organizations interested in baseball. If you want it for a showing to your own group or club, ask us.

Light Weight

We are intrigued by a note in the January *Aluminum News-Letter* to the effect that Reed-Prentice has built some heavy-duty precision lathes of light-weight construction for installation on ships of the U. S. Navy. Cabinet legs, headstock cover, handwheels, and other parts are made of heat-treated aluminum to reduce weight without sacrificing strength and rigidity. This sounds like a most attractive idea for outfitting traveling machine shops and other mobile equipment where weight is an important consideration.

Counterpoint

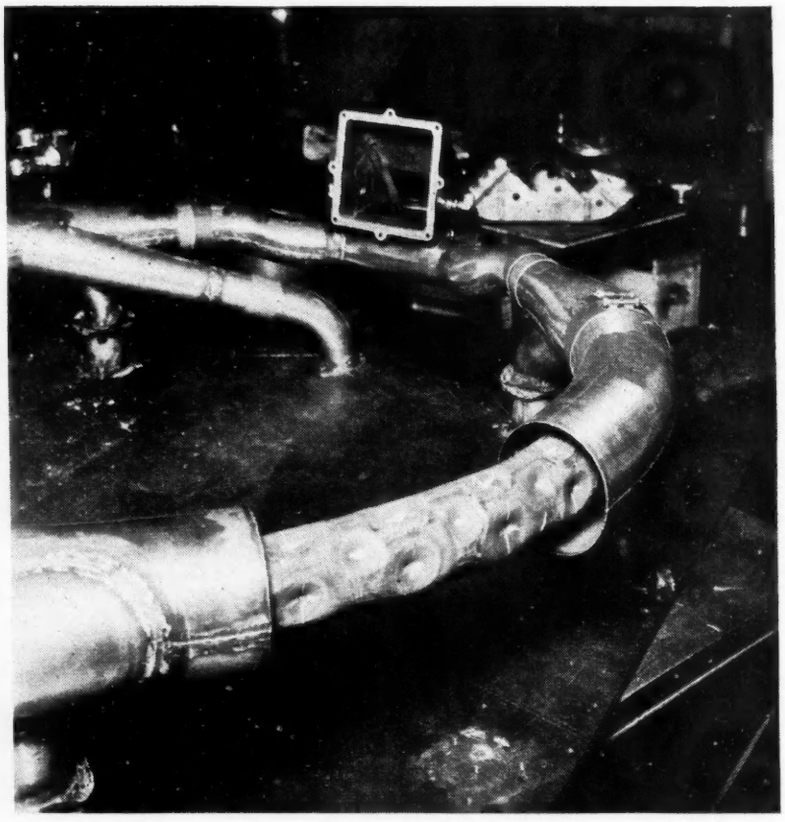
We give you two extremes of manufacturing philosophy gleaned from our travels about the circuit in recent months. One is a parts maker whose product is almost tailor-made for each customer. Heart of the plant is the gear department. They have worked out a smart scheme whereby a limited amount of gear cutting equipment is utilized for the entire gamut of gear requirements. Here the design of the product is bent to suit the tooling. As a contrast we give you another parts maker whose product depends upon unique and proprietary design. They recently built a new plant in which the entire layout and tooling were made to conform to the product design. Two plants — two different philosophies but both with the same objective—a quality product at a price.

Strong Magnets

Intensive research the world over during past few years has produced a series of unusual alloys from which magnets of unusual strength and permanency have been made. Amazing feature of the new magnetic alloys is the compactness and lightness of the resulting instrument, witness the history of the now familiar Alnico. Viewed from this background, engineers and research metallurgists will be interested in a new bulletin issued recently by International Nickel, devoted to a painstaking study of Iron-Nickel alloys for magnetic purposes. It is comprehensive and replete with technical information and design data. We can get it for you.

Plastic Inlay

One of our friends of long standing is in Detroit discussing with prominent automobile manufacturers the details of a new process of producing metal inlays in plastics. The company has patented the essential features of a technique which permits the use of metal inlays in various forms and decorative treatment, promising wide application in the fast moving utilization of plastics in motor cars.—J. G.



Section of Inconel manifold removed to show heater tube installed within (Pollack Mfg. Co.)

A YEAR

IN his "Review of the Nickel Industry in 1938," Robert C. Stanley, president of the International Nickel Co. of Canada, Ltd., deals with developments in the automobile and aircraft industries, among others.

In the United States and Canada, he says, changes in passenger-car engineering have been directed toward styling, greater refinements in design, and the use of lower-cost materials. Steels with lower alloy content are used more extensively, and for some parts the alloy additions have been eliminated entirely. In England and France, on the other hand, the position of nickel-containing steels has been maintained, and in some cases steels of higher nickel content are being introduced to meet exacting service requirements.

In England the automotive industry consumes large quantities of 1 per cent nickel case-hardening steel in place of the plain carbon steel used hitherto for such parts as piston pins and camshafts. The main reason for this change is that nickel steel possesses greater tensile strength and has a higher and more consistent shock resistance than plain carbon steel.

There has been an increase in the use of nickel austenitic steels for exhaust valves, the nickel content ranging from 8 to 20 per cent, 14 per cent nickel being a favorite composition. In special cases the thickness of nickel plating has been increased as much as 50 per cent. The bright nickel process has been widely adopted, notably for automotive hardware. Use of chromium-nickel stainless steel trim is increasing, and nickel additions are being made to the straight-chromium steels to improve their welding characteristics.

World-wide interest has been aroused in the sporting duel between Capt. George Eyston and John Cobb in their respective attempts to better the land world speed record. Nickel played a prominent part in association with steels, light alloys, and bronze in the engines and other components of both vehicles. In both these cars the exhaust manifolds were "Inconel."

During the past few years British motorcycles have been conspicuous in winning road races both in the United Kingdom and overseas. Here again, the makers of these machines employ nickel steels to a considerable extent in engines and other parts.

The significance of corrosion as an important factor in the wear of automobile cylinders has been demonstrated by research work in England and, consequently, interest in the use of corrosion resisting "Ni-Resist" cast iron for cylinder liners is growing to such an extent that more than one foundry has had to consider expanding its facilities in order to meet the growing demand. Another increasing application of "Ni-Resist" is for exhaust manifolds.

The problem of eliminating piston ring groove wear in light alloy pistons has been largely overcome by using a carrier insert of "Ni-Resist" iron which matches the expansion properties of the aluminum alloy. This type of piston construction is increasing in popularity in the United Kingdom, and at the present time some 40 engine builders either are using these pistons as standard or are experimenting with them. The range now being manufactured includes those of small Diesel engines with cylinder bores of 3 in. up to those for engines with cylinder bores of 9½ in. Besides the elimination of wear, this construction is overcoming trouble with rings sticking, a common fault in modern high-speed Diesel engines.

Efforts to economize by using nickel-free steels were reported from France to have resulted in a loss in dependability and a consequent return to the nickel steels. The high cost of gasoline there has stimulated the demand for gas-driven trucks. Compressed gas is carried in cylinders of nickel chromium-molybdenum steel to improve the strength-to-weight ratio.

Two large tractor manufacturers in Italy have adopted 1.5 per cent nickel iron for cylinders. Steel containing 1.8 per cent nickel and 1.0 per cent chromium is specified for other important parts.

The Society of Mechanical Engineers of Japan published in August a comprehensive survey of the materials used for automobile engine parts in that country. Of 34 kinds of cylinder liners for automobile internal combustion engines manufac-

# of NICKEL

tured in Japan, nickel-chromium cast irons are being used for 24. Of 41 kinds of pistons, seven are of the nickel-aluminum alloy type materials, four are nickel-chromium cast iron, three are aluminum-silicon nickel alloy and one is nickel-aluminum-copper alloy. Thirty-two kinds of piston rings for internal combustion engines include four of low nickel-chromium iron, and out of 34 kinds of crankshafts for internal combustion engines, six are of nickel-chromium steel.

In the United States, as well as in other countries, the use of high grade nickel alloy steels in buses, trucks, tractors and industrial trucks continues as in the past, and in several cases has shown an increase in the amount of nickel per vehicle. In all heavy-duty units, both gasoline and Diesel types, the use of nickel cast iron continues for cylinder blocks, heads, liners, pistons, brake drums, exhaust manifolds. Under conditions of high temperature operation "Ni-Resist" is being used, and at least in one case the nickel content has been increased as high as 30 per cent, with 5 per cent of chromium to obtain the necessary heat-resisting properties. "Z" nickel is employed for the fishpole type aerials for automobiles where resistance to rusting and good mechanical properties are required. These aerials are telescoped in "Monel" tubing.

Use of high strength, corrosion-resistant nickel-copper steels has shown a substantial increase in the construction of truck bodies, dump bodies, trailers and tanks for transporting gasoline and other liquids.

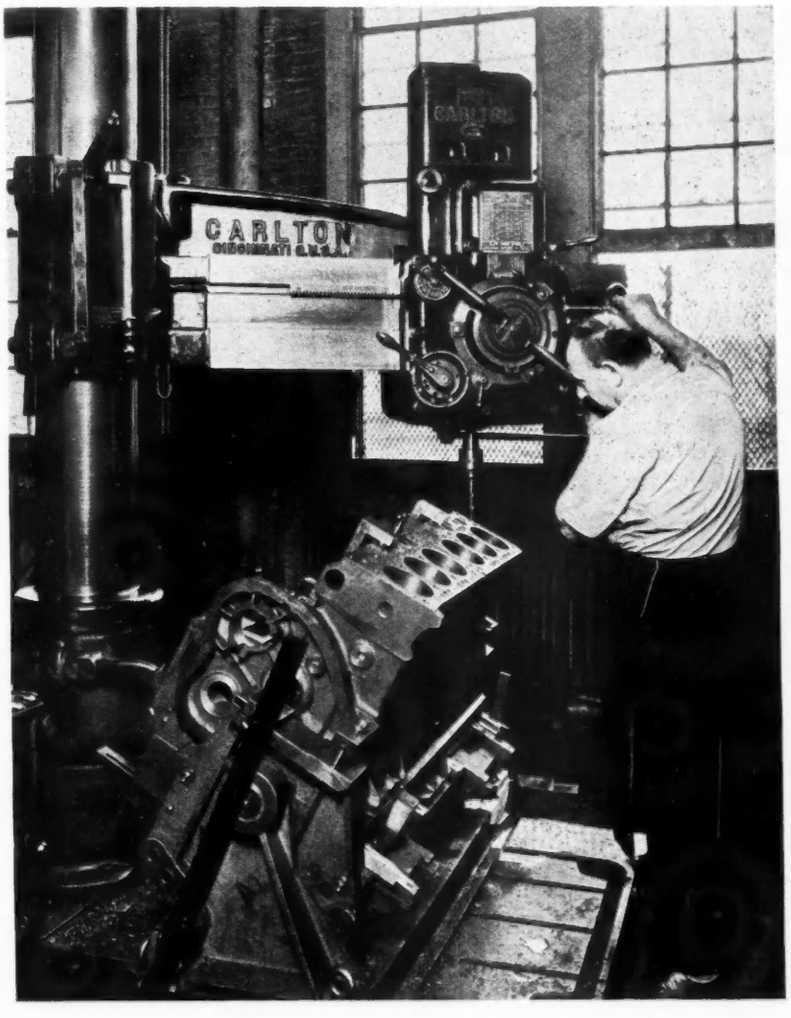
Nickel in Aviation

The year 1938 was marked by rapidly increasing aircraft production throughout the world. In the United States, for example, both domestic and export business far exceeded that of any previous year. It is reliably estimated that total production of planes, engines, accessories and parts for the entire year will exceed a value of $160,000,000 as against $115,000,000 in 1937.

Nickel has always been the fundamental alloying element for steels subject to wear, as well as for highly stressed parts for aircraft engines. This role continues unchanged. Straight nickel steels and nickel-chromium, nickel-molybdenum and nickel-chromium-molybdenum steels with nickel contents up to 5 per cent remain the standard materials for gears, connecting rods, crankshafts, cam rings, piston and knuckle pins, rollers, studs, bolts, nuts, roller bearings, shafting and numerous other important parts. The use of these materials not only assists manufacturers to obtain reliability but also makes possible low weight to-horsepower ratios without sacrifice of safety.

This latter consideration is particularly pertinent in the face of a steady drive for increased horsepower per cylinder and per engine. Radial high-power engines, formerly confined in the main to nine cylinders in a single row, are now manufactured with 14 cylinders in two rows, with maximum power for take-

(Turn to page 379, please)



Radial drilling operations on Mack block. The nickel content allows a speed of more than one and one-half times that possible on unalloyed cast iron

Torsional Vibration of Diesel

By O. MALYCHEVITCH, A.E.

THE theory of vibration as applied to the calculation of multi-cylinder crankshafts has occupied the attention of engineers for the past 40 years, especially that of engineers in the field of heavy Diesel engines. As a result of analyses and test work by Frahm, Holzer, Gümbel, Lewis, Timoshenko, Carter, Hartog, Dorey, Wilson, Porter and others, whose publications have been of great assistance and are duly acknowledged in the bibliography, a method of determining the risks of shaft breakage and of assuring smooth performance while the engine is still in the design stage, has been developed.

When the speeds of gasoline engines reached the figure of 5000 r.p.m., it was found desirable to provide the crankshaft with dampers, especially in the case of long crankshafts such as those of eight-in-line engines. The recent rapid development of the high-speed automotive-type of Diesel engine, and many shaft failures and troubles in actual operation, have brought the torsional-vibration problem to the front in connection with this type of engine. In the following are given a series of calculations of crankshafts, preceded by brief explanations intended to clarify the meaning and application of the calculations. For a detailed study of the subject the reader is referred to the bibliography appended to this article.

The crankshafts referred to are for four- and six-cylinder high-speed automotive Diesel engines of the same bore and stroke, compression ratio, i.m.e.p., and weights of reciprocating and rotating parts. The crankshafts of both engines are identical in every respect except that of length, but the flywheel of the four is heavier than that of the six. The crankshafts are of the five- and seven-bearing types, respectively, and their proportions are representative of the practices of leading U. S. and European Diesel-engine builders.

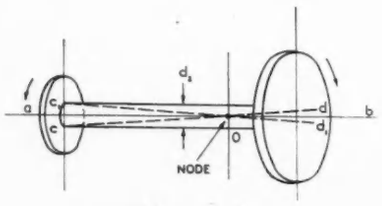


Figure 1

* * *

Every rotating elastic shaft carrying heavy masses and subjected to periodic torque variations is liable to develop torsional vibration. If the shaft d_2, Fig. 1, is subjected to turning moments at both ends, one moment being clockwise, the other counter-clockwise, and is then released, torsional vibration will be produced; the shaft will move alternately to opposite sides of its position of rest, and the movement will be repeated again and again, each time with a slightly decreased amplitude, until finally the vibration ceases.

Experiment has shown that at certain speeds such vibration will produce very high stresses in the shaft. There will be a point *O*, which will not move during the oscillation, and this is called the nodal point, or nodal section, or simply the node of the vibration. The assembly represented by Fig. 1 is called a two-disc or two-mass system with single-node vibration. The line *ab* drawn on the surface of the shaft parallel to its axis will change during vibration to *cd* or c_1d_1, depending on the direction of flexure. The vibration illustrated by Fig. 1 is called free vibration, and for any definite system this vibration has a definite frequency called the natural frequency of the system.

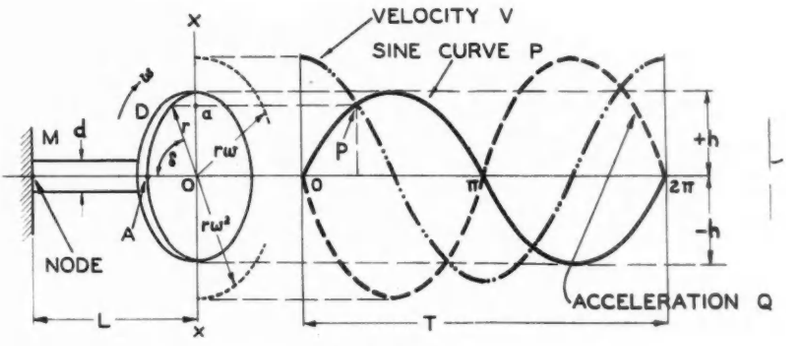


Figure 3

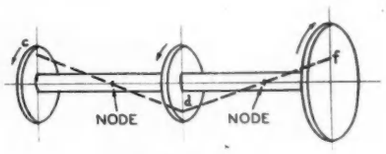


Figure 2

In the case of a three-mass system as illustrated in Fig. 2, if the two end discs are subjected to turning moments in the same direction and the center disc to a turning moment in the opposite direction, there will be two nodes, and the natural frequency of the system will be different, being much higher than for a similarly dimensioned two-disc system with single-node vibration. In shafts carrying a plurality of attached masses there may be vibration with three, four, or more nodes, depending upon the number of lengths of shafting between attached masses.

The lines *cd* and *df* in Fig. 2 are

Engine Crankshafts

Part One

Owing to space limitations it is necessary to print Part Two of this treatise in next week's issue.

called deflection curves, or normal elastic curves, which terms will be defined later. When a shaft of a one-mass system as represented in Fig. 3 is deflected and released, it will vibrate through gradually decreasing angles. This is the simplest form of harmonic motion, and the maximum displacement of point D along line xx is called the amplitude of vibration and is usually designed by the symbol $\pm h$. The instantaneous angular displacement of point D is

$$\delta = \omega t$$

where ω is the phase velocity of vibration (velocity of point D) in radians per second and t the time in seconds occupied in moving from A to D.

The period T in seconds of one cycle (360 deg. or 2 π) is

$$T = \frac{2\pi}{\omega}.$$

The number of complete cycles per second, also called the frequency of vibration, is

$$f = \frac{1}{T} = \frac{\omega}{2\pi}.$$

From Fig. 3 it can be seen that the displacement of point D during the time interval t is

$$p = r \sin \omega t.$$

The velocity, which is represented by the vertical projection of vector $r\ \omega$, 90 deg. ahead of vector r, is

$$v = r\ \omega \cos \omega t.$$

The acceleration is represented by a vertical projection of vector $r\ \omega^2$, 180 deg. ahead of vector r, and is

$$q = r\ \omega^2 \sin \omega t.$$

The natural frequency of vibration of a single-mass system is

$$= \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{M}{I}} \quad \text{cycles per second}$$

$$\text{or } f = \frac{60}{2\pi}\sqrt{\frac{M}{I}} = 9.55\sqrt{\frac{M}{I}} \quad \text{cycles per minute} \qquad (1)$$

The natural frequency of a two-mass system with one node is

$$= \frac{1}{2\pi}\sqrt{\frac{M\,(I_1 + I_2)}{I_1\,I_2}} \quad \text{cycles per second}$$

$$\text{or } f = \frac{60}{2\pi}\sqrt{\frac{M\,(I_1 + I_2)}{I_1\,I_2}} = 9.55\sqrt{\frac{M\,(I_1 + I_2)}{I_1\,I_2}} \quad \text{cycles per minute} \qquad (2)$$

where:

$$M = \frac{G\pi d^4}{32L} = \frac{GJ}{L} \quad \text{lb-in. per radian} \qquad (3)$$

M is the torsional rigidity or stiffness of the shaft, or the torque required to deflect the shaft one radian torsionally.

$J = (\pi\ d^4)/32$, the polar moment of inertia of a circular shaft, in in.^{4}

L, the length of the shaft in in.

G, the modulus of rigidity (11.8 $\times$ 10^6 to 12.3 $\times$ 10^6 lb. per sq. in. for steel). In our calculations we will take G to be equal to 12 $\times$ 10^6 lb. per sq. in.

$I = (W\ R^2)/g$, the moment of inertia of the disc, ... (4)

where W is the weight of the disc in lb.; R, the radius of gyration in in., and g the constant of gravity in in.-sec.$^{-2}$ units (386).

The phase velocity:

$$\omega = 2\pi f \text{ radians per sec.}$$

$$\omega = \frac{2\pi f}{60} \text{ radians per min.} \qquad (5)$$

$$\omega^2 = \frac{M\,(I_1 + I_2)}{I_1\,I_2} \text{ rad}^2\text{-sec.}^{-2}$$

See Fig. 1 for the two-mass system.

Six-Cylinder Engine

Frequency Calculation One-Node Vibration

TABLE I
Figs. 10-11-12.

f_1 = 18440 cycles per min. $\qquad \omega_1^2$ = 3,700,000 rad^2-sec.$^{-2}$

1	2	3	4	5	6	7	8	9	10	11	12
Cyl. Mass No.	d	l	I Eq. 14	$I\omega^2$	ϵ Eq. 9	$I\omega^2\epsilon$	$\Sigma I\omega^2\epsilon$	$M = \frac{GJ}{l}$ Eq. 3	$\frac{\Sigma I\omega^2\epsilon}{M}$	$I\epsilon^2$	S Eq. 13
1	3	7	0.22	0.814×10^6	1.0000	0.814×10^6	0.814×10^6	13.7×10^6	0.0595	0.2200	$\pm$0.2680
2	3	7	0.22	0.814×10^6	0.9405	0.765×10^6	1.579×10^6	13.7×10^6	0.1150	0.1944	0.5210
3	3	7.5	0.22	0.814×10^6	0.8255	0.672×10^6	2.250×10^6	12.8×10^6	0.1758	0.1500	0.7400
4	3	7	0.22	0.814×10^6	0.6497	0.526×10^6	2.777×10^6	13.7×10^6	0.2020	0.0928	0.9100
5	3	7	0.22	0.814×10^6	0.4477	0.364×10^6	3.140×10^6	13.7×10^6	0.2290	0.0440	1.0310
6	3	9	0.22	0.814×10^6	0.2180	0.177×10^6	3.317×10^6	10.7×10^6	0.3085	0.0104	1.0850
FLW	.....	.....	10.0	37×10^6	-0.0905	-3.317×10^6	0	.....	.....	0.0810	.....
									$\Sigma I\epsilon^2$ = 0.7926		

Forced Vibration

If in addition to the weight of the masses (Figs. 1 and 2) representing the flywheel, pistons, connecting rods, crankpins and crank arms, we consider the gas pressure acting on the pistons, as represented by the indicator diagram of the Diesel engine, we find that the latter induces torsional vibration of the shaft, and "forced vibration" of the system results. The frequency f of free vibration of the shaft and the frequency f_1 of forced vibration are independent of each other; but when, at a certain engine speed, the frequency of natural vibration of the shaft coincides with the forced frequency, the phenomenon of "resonance" appears, and if there are no damping forces in the system the amplitude of vibration can increase indefinitely.

Resonance occurs whenever the ratio of natural frequency f in cycles per min. to the shaft speed in r.p.m. is one of the following series of numbers (or harmonic orders): k = ½, 1, 1½, 2, 2½, 3, 3½, 4, 4½, 5, 5½, 6, 6½, etc. (for a four-stroke engine). The speed N at which resonance occurs is called the critical speed.

$$N = \frac{f}{k}$$

For the six-cylinder engine of our example (see Table I), for which f = 18,440 cycles per min., the various important critical speeds are as follows:

$N_{5.5}$ = 18,440/5.5 = 3350 r.p.m. for the 5.5 harmonic;
N_{6} = 18,440/6. = 3000 r.p.m. for the 6. harmonic;
N_{7} = 18,440/7. = 2640 r.p.m. for the 7. harmonic;
N_{8} = 18,440/8. = 2300 r.p.m. for the 8. harmonic,

and so on.

When there is resonance, or when the engine is running at a critical speed, the stresses in most cases may become large enough to cause shaft breakage, and to prevent such breakage the elastic properties and the dynamic force of the system must be suitably proportioned and the operating-speed range of the engine must be so limited as not to include any of the more important critical speeds.

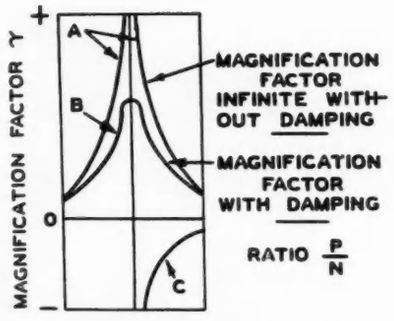


Figure 4

Magnification Factor

The ratio of the amplitude of forced vibration at N r.p.m. to the amplitude of free vibration is called the magnification factor

$$\gamma = \frac{h_1}{h} = \frac{1}{1 - \left(\frac{p}{n}\right)^2} \quad \ldots (6)$$

where p is the frequency of free vibration, and n the frequency of forced vibration.

From Equation (6) we see that γ is positive when p is less than n, negative when p is greater than n (Curve C) and infinite (without damping) when p is equal to n.

Fig 4 shows the magnification factor with and without damping for different frequency ratios. We notice that without damping, the amplitude increases indefinitely when the frequency of natural vibration of the shaft is equal to the frequency of forced vibration (p/n = 1), and with the aid of Equation (6) a resonance curve may be constructed that is similar to Curve A of Fig. 4.

If the ratio p/n is small, or the frequency of forced vibration is below the frequency of natural vibration of the shaft, the magnification factor is also small and will be close to unity.

As a condition of resonance is approached, the magnification factor grows rapidly; but in dealing with the actual crankshaft, where damping forces are present, Curve A will become a Curve B, the vibration amplitude will never reach an infinite value, and the resonance curve will be represented by a curve similar to B.

Damping Elastic Hysteresis

Damping forces may be either external or internal. External damping forces include such items as friction in bearings or between piston and cylinder wall, while the internal damping force consists of the molecular friction of the material of the vibrating crankshaft. Engine friction is comparatively small and can be neglected, and in the following we will consider only the intermolecular friction of the crankshaft material, which results in the generation of heat.

Flexing of the shaft in torsional vibration at below its elastic limit, under continuously changing torque, requires the expenditure of energy. The greater part of this energy is stored in the shaft; however, a certain amount of the energy is absorbed by the molecular friction of the material, this being called "elastic hysteresis."

Tests show that when a shaft is subjected to torsional moments, the stress-strain curve obtained does not exactly follow Hooke's law, but forms a closed loop (Fig. 5). The area *MNPQ*, which is called the hysteresis loop, represents the energy dissipated during each cycle, and is a measure of the damping properties of the crankshaft material. Rowett, Canfield and Dorey have made important contributions to our knowledge on the subject of the damping characteristics of materials. Doctor Dorey gives the value of the hysteresis constant C as 2100 for nickel-chromium steel, with a critical stress of 120,000 lb. per sq. in., when stressed below the critical range. It is an accepted rule of practice that for reverse torsion in the above-mentioned steel, the permissible safe working stress is 10 per cent of the ultimate tensile strength, or 10,000 lb. per sq. in.

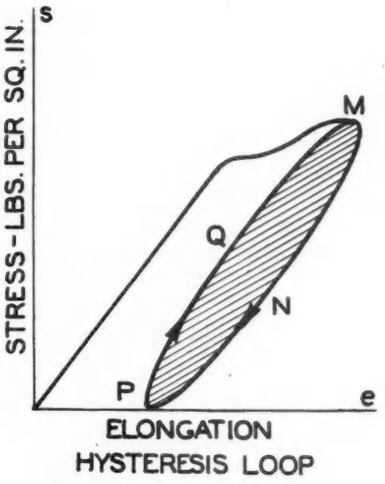


Figure 5

On the basis of Dr. Dorey's experiments, Dr. W. Wilson gives the following expression for the maximum stress at resonance:

$S = C \sqrt{Q}$ lb. per sq. in.,. . . . (7)

and for the magnification factor at resonance.

$$\gamma = \frac{C}{\sqrt{Q}}, \quad \ldots \quad (8)$$

where S is the maximum vibration stress at resonance in lb. per sq. in., and Q the free-vibration stress in lb. per sq. in. In our case $Q = sA$,

Six-Cylinder Engine

Frequency Calculation One-Node Vibration

TABLE II
Figs. 13-14-15.

f_2 = 51500 cycles per min. ω_2^2 = 29,090.909 rad²-sec.$^{-2}$

1	2	3	4	5	6	7	8	9	10	11
Cyl. Mass No.	d	l	I Eq. 14	$I\omega^2$	ϵ Eq. 9	$I\omega^2\epsilon$	$\Sigma I\omega^2\epsilon$	$M = \frac{GJ}{l}$ Eq. 3	$\frac{\Sigma I\omega^2\epsilon}{M}$	S Eq. 13
1	3	7	0.22	6.4×10^6	1.0000	6.40×10^6	6.40×10^6	13.7×10^6	0.4664	±20850
2	3	7	0.22	6.4×10^6	0.5336	3.41×10^6	9.81×10^6	13.7×10^6	0.7160	32000
3	3	7.5	0.22	6.4×10^6	−0.1824	-1.16×10^6	8.65×10^6	12.8×10^6	0.6757	28300
4	3	7	0.22	6.4×10^6	−0.8581	-5.50×10^6	3.15×10^6	13.7×10^6	0.2299	10500
5	3	7	0.22	6.4×10^6	−1.0880	-6.97×10^6	-3.82×10^6	13.7×10^6	−0.2788	12420
6	3	9	0.22	6.4×10^6	−0.8092	-5.17×10^6	-8.99×10^6	10.7×10^6	−0.8401	29000
FLY	.....	.....	10.00	290.9×10^6	0.0309	8.99×10^6	0	.....	.....	.....

where s = 10,850, the maximum stress for one deg. of deflection (see Table I, col. 12); A is the amplitude of vibration (Equation 12), and C, the hysteresis constant, which is equal to 2100.

According to Doctor Dorey, the hysteresis constant C varies with the composition of the steel, being equal to 1250 for 3 per cent nickel steel and to 1100 for carbon steel. It is interesting to note that when the material is stressed beyond the critical range, carbon steel with a hysteresis constant of 1100 has a higher vibration quality than high-tensile steel. However, in Diesel engines, with their high explosion pressures, the stresses in the crank arms must be kept within the permissible limits without undue increase in the thickness of the arms, which would result in lengthening the crankshaft and the cylinder block, and would add considerably to the weight and size of the engine, so it is advisable to use alloy steels.

Normal Elastic Curve

To find the maximum stress at the node of the crankshaft and the stress at any other section of the shaft during free vibration, it is necessary to determine the normal elastic curve (see Fig. 6 and Tables I and II). The normal elastic curve represents the value of the angular amplitude ϵ at the centers of the various crank-train masses and of the flywheel. These amplitudes are indicated in Fig. 6. The amplitude of the mass of cylinder No. 1 may have any arbitrary value, and is usually taken as ϵ = one radian.

The angular amplitude at cylinder No. 2 then is

$$\epsilon_2 = \epsilon_1 - \frac{I_1\omega^2}{M_1}\epsilon_1 \quad \text{and that at cylinder No. 3,} \quad \epsilon_3 = \epsilon_2 - \frac{\omega^2}{M_2}(I_1\epsilon_1 + I_2\epsilon_2), \text{ etc.} \qquad (9)$$

where

I_1 is the moment of inertia of mass No. 1 in lb.-in-sec.²;

ω^2, is the phase velocity in rad.²-sec.$^{-2}$ (Equation 5);

M_1, the torsional rigidity or stiffness of shaft, in lb.-in. per radian (Equation 3);

ϵ_1 = 1 radian, the angular amplitude at cylinder No. 1.

Example: Angular amplitude at cylinder No. 2 (Equation 9) (see Table I, cols. 6 and 10)

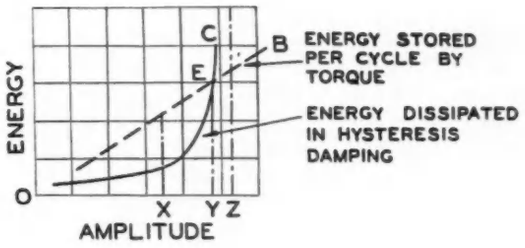


Figure 7

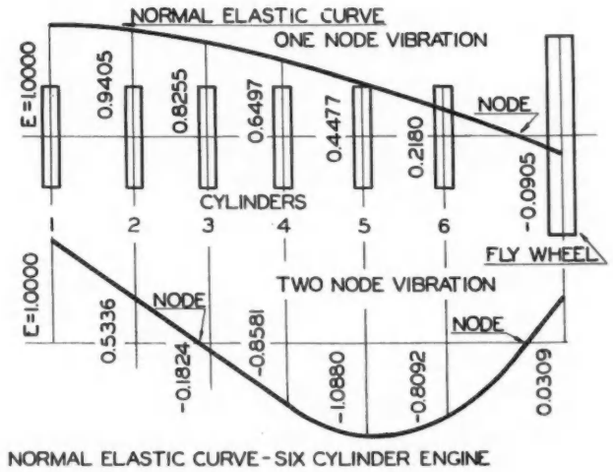


Figure 6

$$\epsilon_2 = \epsilon_1 - \frac{I_1\omega^2}{M_1}\epsilon_1 = \epsilon_1 - \frac{I_1\omega^2}{\frac{GJ}{L}}\epsilon_1$$

$$\epsilon_2 = \epsilon_1 - \frac{\text{Col. 8}}{\text{Col. 9}}\epsilon_1 = 1 - \frac{0.814 \times 10^6}{13.7 \times 10^6} = 1 - 0.0595 = 0.9405$$

At cylinder No. 3,

$$\epsilon_3 = \epsilon_2 - \frac{\text{Col. 8}}{\text{Col. 9}} = 0.9405 - \frac{1.579 \times 10^6}{13.7 \times 10^6} = 0.9405 - 0.1150 = 0.8255$$

Amplitude of Torsional Vibration

Forced torsional vibration of the crankshaft is induced by variations in the gas-pressure torque. The torque curve is very irregular, but it repeats itself every two revolutions (in a four-stroke engine), and the torque, therefore, can be represented by the well-known Fourier series with harmonic components of the ½, 1, 1½, 2, 2½, etc., orders. By equating the work done by the harmonic torque during one cycle to the work absorbed by damping (elastic hysteresis), we can determine the amplitude A of the vibration.

In Fig. 7 line OB represents the work done by the force P at resonance; line OC, the work done by the damping forces per cycle. The two curves intersect at E, the point of energy equilibrium, which corresponds to an amplitude $A = O\gamma$. Amplitude Ox shows that at that stage less energy is given up than is put into the system, while with an amplitude Oz the energy absorbed by the damping medium exceeds the energy put into the system by the vibration. Combining the work done by force P with a damping force which increases with the amplitude of vibration but always tends toward point E of energy equilibrium, has the effect of reducing the resonance peaks. We have what may be called free vibration of the system, and the work done by all cylinders per cycle may be expressed by the Equation

$$U \Sigma_\epsilon = P B R \Sigma_\epsilon \ldots\ldots (10)$$

where U is the harmonic torque $= P \times B \times R$ ..... (11)

$\Sigma\ \epsilon$, the vector sum of ordinates of the normal elastic curve for any particular firing order and for the critical speeds of the different orders is found from the vector diagram (Table V). As already mentioned, the ordinates of a normal elastic curve represent the amplitudes of vibration of the moving masses in the various cylinders.

P, the harmonic coefficient in lb. per sq. in. per unit crank radius as given by Prof. Lewis (Figs. 9a and 9b).

R, the crank radius, 2.25 in.

B, the area of the cylinder bore, 11 sq. in.

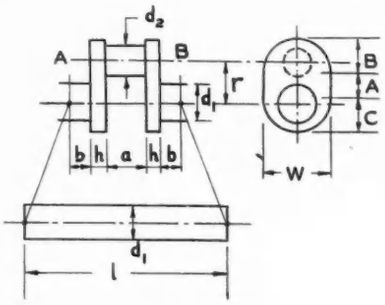


Figure 8

If the natural frequency of vibration f = 18,440 cycles per min. (Table I) and the moment of inertia of the system $\Sigma I \epsilon^2 = 0.7926$ (Table I, col. 11), the amplitude of vibration of the crank farthest from the flywheel may be expressed by

$$A = \frac{5230\, U \Sigma\epsilon}{I \epsilon^2 f^2} \text{ deg.}$$

$$\text{or } A = \frac{5230 \times 11 \times 2.25 \times P\Sigma\epsilon}{0.7926 \times 340 \times 10^6} = 0.0005\, P\Sigma\epsilon \ldots\ldots\ldots (12)$$

At resonance the maximum amplitude of vibration at the free end of the crankshaft is

$$A_{max.} = A\gamma \text{ deg.}$$

where γ is the magnification factor (Equation 8).

Harmonic coefficients P (Equation 10) for four-stroke Diesel engines with a connecting-rod crank radius ratio of 4.25, for critical speeds of the ½ to 12th order and for i.m.e.ps. of 20 to 140 lb. per sq. in. have been calculated by Professor Lewis and are shown graphically in Figs. 9a and 9b. The values there given can be used also for other connecting rod/crank radius ratios.

Harmonic analysis of the engine torque curve can be effected by means of a special instrument called a harmonic analyzer, as well as by the analytical method, which analysis is beyond the scope of this article.

Shearing Stresses

According to the investigations of St. Venant, elastic deformation of a long shaft in torsion produces a shear stress which depends only on the magnitude of the torque T and can be expressed by the equation

$$S = \frac{Tr}{J}$$

where $T = \Sigma I \omega^2 \epsilon$ is the total torque applied to each end of the shaft (Fig. 11, also Table I, col. 8), in lb.-in. per radian of deflection at mass No. 1.

$r = d/2$, is the radius of the shaft in in., and

$J = (\pi d^4)/g = (\pi d^4)/32 = 8$ (for a 3-in. shaft) is the polar moment of inertia of the shaft.

As one radian is equal to 57.3 deg., the shear stress in any section of the shaft for 1 deg. deflection at mass No. 1 (see Table I, col. 12, and Fig. 12) is

$$S = \frac{Tdg}{2\pi d^4 \times 57.3} = \frac{\Sigma I\omega^2\epsilon}{303.5} \text{ lb. per sq. in. per deg. .. (13)}$$

Equivalent Length and Moment of Inertia of Each Crank Unit

The equivalent length of the crank unit (Fig. 8) is the length l of a shaft of the same diameter d_1 as the journal which, if subjected to the same torque, will show the same torsional deflection. It can be calculated by means of a well-known formula developed by B. C. Carter, according to which the equivalent length from A to B is

$$l = (2b + 0.8h) + 0.75\left(\frac{d_1^4}{d_2^4}\right) a + 1.5r\frac{d_1^4}{h\omega^3} = 7 \text{ in.}$$

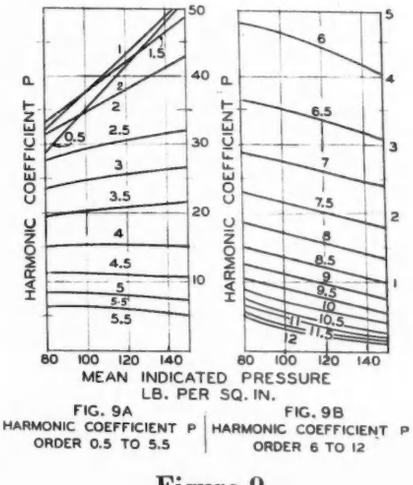
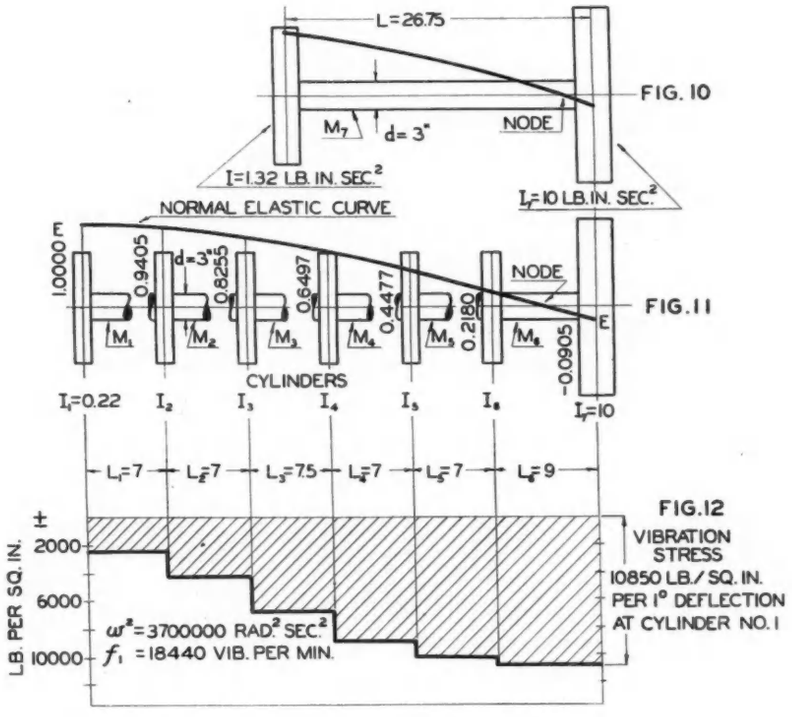

HARMONIC COEFFICIENT P
HARMONIC COEFFICIENT P
MEAN INDICATED PRESSURE LB. PER SQ. IN.
80 100 120 140
80 100 120 140
FIG. 9A HARMONIC COEFFICIENT P ORDER 0.5 TO 5.5
FIG. 9B HARMONIC COEFFICIENT P ORDER 6 TO 12

Figure 9



Figures 10, 11 and 12

The equivalent length of the whole crankshaft is

$$L = 3 \times 7 + (1.7 \text{ to } 2)\, d_1 = 26.75 \text{ in.}$$

The moment of inertia of the front and intermediate crank journals, each of which has a diameter d_1 of 3 in., a length l of 1.4 in., a weight W of 2.76 lb., and a squared radius of gyration $m^2 = d_1^2/8$ of 1.12, is found to be

$$I_1 = \frac{Wm^2}{386} = \frac{2.76 \times 1.12}{386} =$$

0.008 lb.-in.-sec.²,

386 representing the gravitational constant in in.-sec.²

For the rear and center main journals d_1 is 3 in.; l, 2.03 in.; W, 4 lb., and m^2, 1.12, so that the moment of inertia of each of these journals is

$$I_2 = \frac{4 \times 1.12}{386} = 0.0116 \text{ lb.-in.-sec.}^2$$

For the crankpin d is 2.5 in.; l, 1.83 in.; W, 2.42 lb., and $m^2 = d_1^2/8 + r^2 = 5.84$.

$$I_3 = \frac{2.42 \times 5.84}{386} = 0.0384 \text{ lb.-in.-sec.}^2$$

The reciprocating parts have a weight W of 6 lb. and an equivalent radius of rotation r of 2.25 in.; hence their moment of inertia

$$I_4 = \frac{Wr^2}{2g} = \frac{6 \times 5.06}{2 \times 386}$$

$$= 0.0393 \text{ lb.-in.-sec.}^2$$

The moment of inertia of the rotating parts is

$$I_5 = \frac{Wr^2}{} = \frac{3.5 \times 5.06}{386}$$

$$= 0.046 \text{ lb.-in.-sec.}^2$$

Where crank arms of special form are used, it is advisable to divide them up into simple geometrical bodies A, B, and C, find the center of gravity, weight and moment of inertia of each, and then make use of the rule that the moment of inertia of a body around any axis parallel to an axis through its center of gravity is equal to its moment of inertia around the axis through its center of gravity plus the product of its weight by the square of the distance between the two axes. The outside axis in this case is the crankshaft axis.

The moment of inertia of the crank arm is

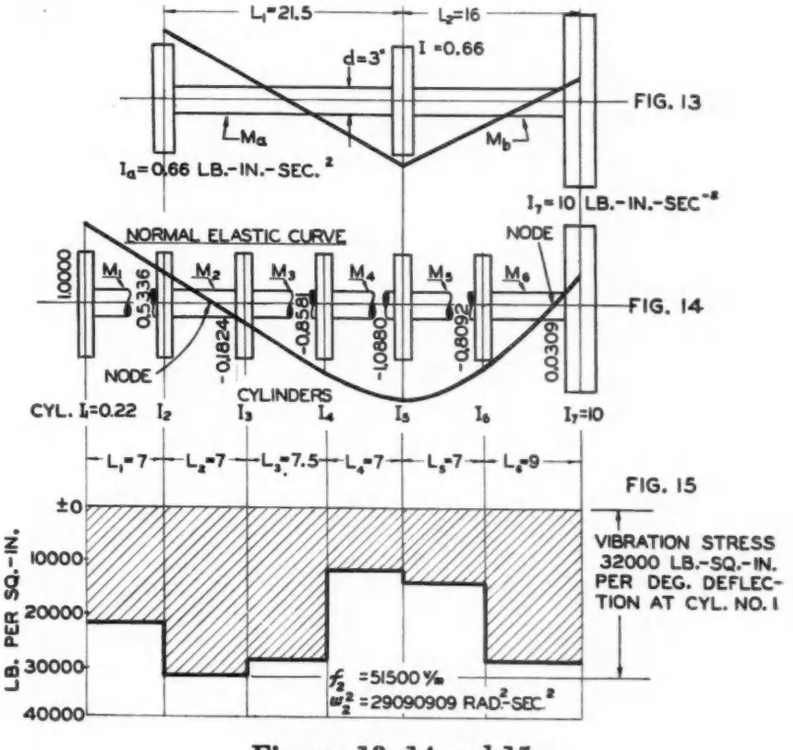
$$I_6 = \frac{15.442}{386} = 0.04 \text{ lb.-in.-sec.}^2$$

The various moments of inertia for the moving parts of the six-cylinder engine add up as follows:

Rotating parts	$6 \times 0.046 = 0.2760$
Reciprocating parts	$6 \times 0.0393 = 0.2358$
Journals, front and interm.	$5 \times 0.008 = 0.0400$
Journals, center and rear	$2 \times 0.0116 = 0.0232$
Crank cheeks	$12 \times 0.04 = 0.4800$
Pins	$6 \times 0.0384 = 0.2304$
Total moment of inertia	$= 12.86$

This makes the moment of inertia per cylinder

$$\frac{12.86}{6} \text{ 0.22 lb.-in.-sec.}^2 \quad \ldots \quad (14)$$



Figures 13, 14 and 15

Six-Cylinder Engine

ONE-NODE FREQUENCY
MAX. VIBRATION STRESSES AT RESONANCE SPEED WITH HYSTERESIS DAMPING

TABLE III
Firing Order: 1-4-2-6-3-5
I.M.E.P. = 100 lb. per sq. in.

f_1 = 18440 cycles per min. ω_1^2 = 3,700,000 rad²-sec.$^{-2}$

13	14	15	16	17	18	19	20	21	22
Harmon Order K	Critical Speed R.P.M. $f : K$	P Fig. 9ab	$\Sigma\epsilon$ Table V	$P\Sigma\epsilon$	A Eq. 12	Q $10850 \times A$	γ Eq. 8	1-4-2-6-3-5 S	A max. Eq. 12
3	6200	25.00	4.0810	102.000	±0.051000	±555.00	90.0	± 50000	±4.60
3½	5300	20.00	0.5000	10.000	0.005000	54.20	286.0	15600	1.43
4	4600	15.00	0.2500	3.750	0.001900	20.60	466.0	9900	0.89
4½	4100	10.10	1.4500	14.500	0.007300	80.00	236.0	19000	1.72
5	3720	8.00	0.2500	2.000	0.001000	10.85	656.0	7250	0.66
5½	3350	6.00	0.5000	3.000	0.001500	16.33	525.0	8600	0.79
6	3000	4.65	4.0814	19.000	0.009500	103.00	210.0	21600	2.00
6½	2840	3.50	0.5000	1.750	0.000900	9.80	700.0	6860	0.63
7	2640	2.80	0.2500	0.700	0.000350	3.80	1100.0	4200	0.38
7½	2460	2.50	1.4500	3.630	0.001800	19.50	470.0	9200	0.85
8	2300	1.60	0.2500	0.400	0.000200	2.17	1470.0	3200	0.30
8½	2170	1.50	0.5000	0.750	0.000380	4.15	1030.0	4300	0.39
9	2050	1.10	4.0814	4.080	0.002100	22.78	446.0	10200	0.94
9½	1940	0.90	0.5000	0.450	0.000220	2.40	1600.0	3880	0.35
10	1840	0.70	0.2500	0.170	0.000085	0.92	2200.0	2000	0.19
10½	1760	0.60	1.4500	0.870	0.000440	4.80	955.0	4600	0.42
11	1680	0.50	0.2500	0.125	0.000060	0.65	2620.0	1700	0.16
11½	1600	0.40	0.5000	0.200	0.000100	1.08	2000.0	2160	0.20
12	1530	0.33	4.0814	1.300	0.000650	6.50	840.0	5500	0.55

The outside diameter of the flywheel rim is 15 in., the inside diameter 10 in., the weight 95 lb., and the square of the radius of gyration, $m^2 = (D^2 + d^2)/8 = 40.6$. Therefore, the moment of inertia of the flywheel is

$$I_7 = \frac{W \times m^2}{386} = \frac{95 \times 40.6}{386}$$

$$= 10 \text{ lb.-in.-sec.}^2$$

The torsional stiffness of the crankshaft is calculated by means of Equation (3) (see also Fig. 11)

$$\left.\begin{aligned} M_1 = M_2 = M_4 = M_5 = \frac{GJ}{l_1} &= \frac{12 \times 10^6 \times 8}{7} = 13.7 \times 10^6 \\ M_3 = \frac{GJ}{l_3} &= \frac{12 \times 10^6 \times 8}{7.5} = 12.8 \times 10^6 \\ M_6 = \frac{GJ}{l_6} &= \frac{12 \times 10^6 \times 8}{9} = 10.7 \times 10^6 \\ M_7 = \frac{GJ}{l_7} &= \frac{12 \times 10^6 \times 8}{26.75} = 3.6 \times 10^6 \end{aligned}\right\} \quad (15)$$

We now have a six-cylinder crankshaft reduced to the system illustrated in Fig. 11, with calculated inertias of 0.22 lb.-in.-sec.² for the moving mass of each cylinder, with a flywheel inertia of 10 lb.-in.-sec.², and torsional rigidities of the shaft units as calculated in Equation (15). For the purpose of calculating the natural frequencies this system is replaced by:

(a) A two-mass system (Fig. 10), one mass representing the six crank units, with a moment of inertia $I = 1.32$ lb.-in.-sec.², the other representing the flywheel, with a moment of inertia of 10 lb.-in.-sec.² This is for the first mode of vibration with one node.

(b) A three-mass system (Figs. 13, 14, and 15), for second-mode vibration with two nodes.

The third, fourth, and higher modes of vibration are of no particular interest in our case.

The natural frequency of the two-mass system with one node according to Equation (2) is

$$f_1 = 9.55 \sqrt{\frac{M_7 (I + I_7)}{II_7}} \text{ or}$$

$$f_1 = 9.55 \sqrt{\frac{3.6 \times 10^6 (1.32 + 10)}{1.32 \times 10}}$$

$$= 17200 \text{ cycles per minute}$$

The phase velocity of the two-mass system is according to Equation (5)

$$\omega_1^2 = \frac{M_7 (I + I_7)}{II_7}$$

$$= \frac{3.6 \times 10^6 (1.32 + 10)}{1.32 \times 10}$$

$$= 1800 \text{ rad/sec.}$$

$$\omega_1^2 = 3{,}300{,}000 \text{ rad}^2\text{-sec.}^{-2}$$

Part Two

of this treatise by O. Malychevitch will be concluded in AUTOMOTIVE INDUSTRIES in the issue of March 25.

MEN and MACHINES

continued from page 362

to ⅜ in. will grind drills to the standard 59 deg. angle at point and 12 deg. clearance angle without adjustment. It has a snap clamp for holding the smaller size drills. Both holders support drills in V-guides—no clamping or chucking is necessary.

Something different in conveyor equipment is the adjustable floor support for conveyors recently developed by the Logan Co., Louisville, Ky. A zig-zag slot in the adjustable foot portion of this conveyor floor support is said to prevent slipping under heavy loads. The conventional type of floor support has a plain vertical slot in the foot portion with the leg being adjusted in height by vertical movement, and secured by nuts and bolts at the desired position. The new zig-zag slot illustrated herewith will hold the leg in position without the necessity of drawing up the nut extremely tight. This maintains correct alignment for the carrying surface of the conveyor, insuring proper operation of the equipment and simplifying the adjustment when changes in height are necessary.

New engineering developments and improvements in speed, simplicity and adaptability are opening up a new and broad sphere of general application of hydraulic presses with many unexpected and worth-while production and assembly economies throughout the metal working industry. The 2500-ton capacity hydraulic press shown herewith is one of 14 various sizes shipped recently to the French Air Ministry by the Lake Erie Engineering Corp., Buffalo, N. Y., for forming duralumin sections of airplane wings, pontoons and fuselage parts. It weighs 392,000 lb., required six freight cars for transportation to the seaboard. The ram of this press measures 42 in. in diameter. Platens are 150 in. by 89 in. The machine is a self-contained unit with electrically driven pumps mounted on its upper deck.

Universal bevel protractor: A precision tool intended for use by toolmakers, engineers, layout men and mechanics. It may be used for all types of work where angles must be laid out or measured. The dial is graduated in degrees for the full circle. A vernier is provided which gives readings within five minutes of the arc. (1/12th of a degree.) George Scherr Co., New York, are exclusive agents in the United States for this Mauser tool.

Arc welder: A machine with a 100 amp. rating at 30 volts for light sheet metal welding and other light work requiring low current and fine control. It is of the alternating current, transformer type, and designed especially for use with heavily coated electrodes. Enclosed in a sheet metal housing 16½ in. in diameter and 24 in. high, weighing 145 lb., the new welder is a compact and mobile unit. It is manufactured by Wilson Welder and Metals Co., Inc., New York.

A Year of Nickel

(*Continued from page* 371)

off up to 1500 hp. Liquid-cooled engines of similarly high rating, with in-line cylinders, are also in regular production. Naturally, the handling of such tremendous power requires materials of the highest quality.

Among the vital parts of an aircraft engine are the valves, which must operate under trying conditions of heat, corrosion and wear. Nickel-chromium steels containing 12 to 16 per cent of nickel are standard materials for this application. Frequently the valves are sodium-filled for cooling, and nitrided on the stems for wear resistances.

The low weight per horsepower of the present high-powered engines is partly due to the use of aluminum-alloy pistons and cylinder heads. To improve the strength of these alloys at the relatively high temperatures at which they operate, compositions containing 1 to 2 per cent of nickel are generally employed.

Aside from the engines, interesting developments leading toward increased applications of nickel alloys have taken place in connection with the ships themselves. The development of improved powerplants has been paralled by intensive efforts to build practical transport and military planes of greatly increased size. . . .

Chromium-nickel iron alloys of high nickel content, including "Inconel," have a wide field of application in exhaust manifolds, heating devices and firewalls.

Great progress has been made in the perfection of controllable pitch and constant-speed propellers which are now universally used on large planes and on many smaller ones as well. Nickel-alloy steels are always specified for spiders and other major parts of the hub assembly. The importance of dependability in this application is obvious.

During the year a prominent engine manufacturer approved the use of nickel nitriding steel for knuckle pins by reason of the improvement nickel imparts to both case and core of nitrided steel. This development has attracted considerable attention.

A relatively small tonnage of cast iron is produced annually for aircraft engines, the cylinder castings usually being made of a high strength nickel-molybdenum or nickel-chromium cast iron. Prospects for extending the use of high-grade cast iron in this industry are developing in the effort to produce a low-cost engine of sufficient power to appeal to popular demand.

From France comes reports of an outstanding achievement in aircraft engine cast iron in which high-strength cast iron, rich in nickel and manganese, is cast in a toughened condition, so that the air-cooling fins are not brittle. After machining, an aging or tempering treatment is applied to provide sufficient hardness and wear resistance.

The outstanding use of "Inconel" in the aircraft industry is for exhaust manifolds, or collector rings, where the metal has to withstand vibration and the heat from the gases. A large number of such manifolds are in transport and military planes and include installations on the Pan-American trans-Atlantic Clipper ships and the Douglas DC-4. For similar reasons the alloy is widely used for flash boilers heated by exhaust gases and used to provide cabin heat. "Inconel" will withstand attack by the hot exhaust gases, the sudden chilling by water intermittently supplied to it, and the

stresses resulting from wide temperature changes and vibration.

The past year has witnessed the growing use of "Monel," for filter cloth in gasoline lines, for valve seats and tanks, and for lavatory, galley and cabin trim. In France alone 110 tons of "Monel" and 15 tons of "Inconel" were consumed by the aircraft industry in 1938.

Development of cadmium as a base of bearing alloys has been rapid in recent years. To fit this metal for bearing service it is necessary to harden it with small quantities of another element, and the most satisfactory metal so far found for this purpose is nickel. Nickel-containing cadmium bearings have been standardized by one of the leading British aero engine manufacturers for all the high-duty bearings.

New Developments in Automotive Materials

(*Continued from page* 368)

nitrate, (b) cellulose acetate, (c) cellulose mixed esters, and (d) cellulose ethers. The best-known plastics of the protein type are those made of casein, which is obtained from milk, and a commercial soy-bean meal molding composition containing a predominant percentage of phenol-formaldehyde resin. The use in plastic compositions of zein obtained from corn, and alpha protein from soy beans is currently being investigated. Formaldehyde is used for the purpose of converting these proteins into hard and stable compounds.

The real romance of this industry rests in the ability of the active and excited younger set of molecules to get together and form by condensation or chain growth the heterogeneous population of giants which we know as plastics. It is also the research into the genetics of these organic compounds that has paid dividends by enabling the chemist to create at will synthetic materials having the hardness of stone, the transparency of glass, the elasticity of rubber, or the insulating quality of mica. Because their chemical heredity and molecular configuration largely determine the properties of the finished products, this exploration of the commercial plastics, in lieu of merely following the path of a census taker, has traced the development of these materials from their "single-cell" progenitors. In Doctor Kline's paper the outstanding characteristics and principal applications of each type of plastic were summarized and detailed references were given to tabulations of information on the properties, methods of fabrication, uses, trade names, and manufacturers and molders of plastics.

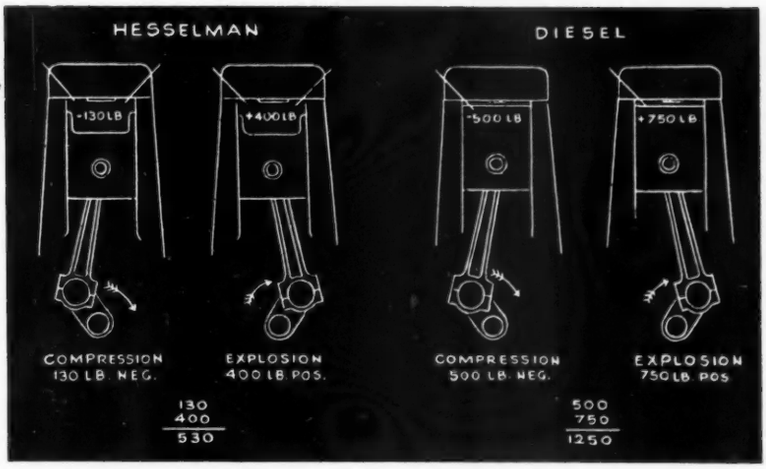
CHILTON ROUND TABLE

(Continued from page 364)

the lack of salesmanship which is displayed. Some would then realize why business does not flow as abundantly their way, as it might.

From Motor Age

The adoption of Diesel power by many truckers has set many service men to thinking about equipping their shops for Diesel service. "Our customers fairly forced us into Diesel service," says Joseph Sirotek, president of the Illinois Auto Electric Co. "We're glad they did," adds Mr. Sirotek, "for now we have a specialized Diesel department so laid out, equipped and manned that we are even authorized to do factory warranty work for Bosch, thus saving customers the annoyance and expense of returning parts to the factory, and at the same time building volume for us."

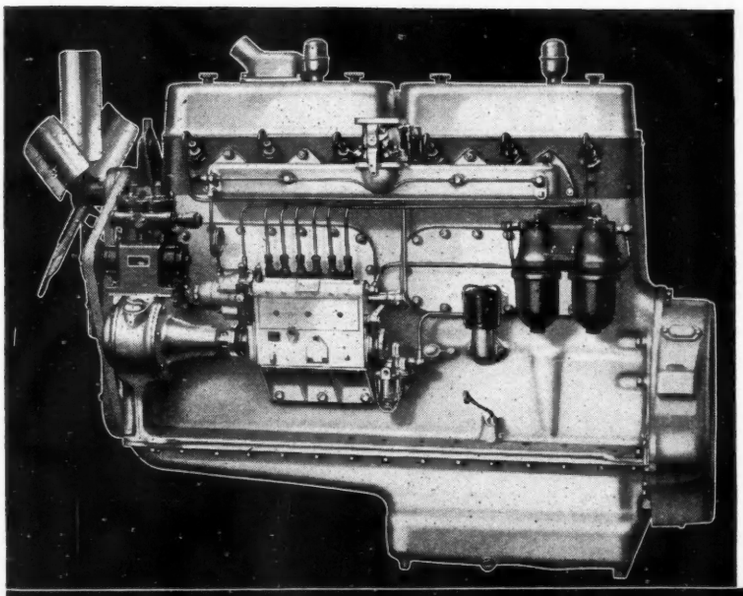


Just Compare Pressures

You have to save a lot of seven-cent gallons of fuel to pay for the added up-keep of a high pressure, compression ignition engine.

In a Hesselman, compression is only 120-130 lb., about one-fourth the pressure needed if it were not for the spark plug ignition. And the explosion pressure of 400 lb. is not even as high as the compression pressure in a Diesel.

In a Diesel the total instantaneous reversal stress at top dead center in the crankshaft is as high as 1250 lb.—more than twice that of Hesselman's 530 lb.



Waukesha-Hesselman Oil Engines have none of the Diesel's high pressure disadvantages. They use positively-timed electric ignition . . . they start in any weather promptly and easily . . . cost little to maintain . . . burn not only any high-speed diesel fuel but all the popular low-cost domestic burner oils . . . perform with all the snap and ginger of a good gasoline engine. *Bulletin 1011* explains all these advantages. *Get it.*

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WAUKESHA-HESSELMAN OIL ENGINES

FOR THE GREATEST OVER-ALL ECONOMY